VOLUME XXII NUMBER 1

BOTANICAL GAZETTE

JULY 1896

ROSÆ AMERICANÆ. I.

OBSERVATIONS UPON THE GENUS ROSA IN NORTH AMERICA.

FRANÇOIS CRÉPIN.

To the Editors of the Botanical Gazette:

The preface to the observations on American roses, which it is my intention to contribute from time to time, I shall put in the form of a letter, which will permit me to enter into the subject more easily. Recently I asked whether your excellent journal would grant me the courtesy of its pages to address American botanists upon the roses of their country, thinking that I would reach them better than if I should continue to publish my observations in European journals. You have kindly granted my request, and I hasten to take advantage of it.

In the first place, I would call the attention of your readers to the fact that twenty years ago (1876) I published a monograph of the American roses,[1] in which I gave a résumé of our knowledge at that time. Ten years afterwards the late Sereno Watson published a similar work,[2] but based upon more abundant material than had served for my monograph. This monograph, of incontestible merit and containing contributions to our knowledge, was after all simply a preparation for a complete presen-

[1] "Prodrome d'une monographie des roses américaines," in *Bull. Soc. bot. Belg.* **15**:—. 1876.

[2] "A history and revision of the roses of North America," in *Proc. Amer. Acad.* **20**:—. 1885.

THE UNIVERSITY LIBRARIES OF GEORGIA

tation of American roses. Watson did not always seize upon the natural affinities which hold together certain forms, being misled by appearances simply or by a misinterpretation of certain characters. Thus, he separated *R. acicularis* Lindl. into two species, one taking the name *R. Sayi* Schwein.; then later into a third species, *R. Engelmanni*.[3] These three species are actually but three varieties of the same specific type. Also he has recognized as a distinct species *R. Arkansana* Porter, which is perhaps but a variety of *R. blanda* Ait. He has preserved as a separate species *R. lucida* Ehrh., which is indeed but a variety of *R. humilis* Marsh. Finally, he has organized two specific groups under the names *R. Fendleri* Crépin and *R. Woodsii* Lindl., each of which seems to me to be composed of heterogeneous elements. As for his *R. Mexicana*, the few specimens which have been collected scarcely permit me to know whether he has well separated it as a distinct species. In any case it seems to belong to the section CAROLINÆ.

In the preface of his monograph Watson says that if the roses were reduced to their primary types North America would contain but nine species. This proposed condensation indicates that he had not acquired sufficient acquaintance with roses, and that he had formed false conceptions of certain forms. It was to call attention to the errors in Watson's work that I published in 1887 and in 1889 a series of remarks upon American roses.[4]

About the same time, another American student of roses, Mr. G. N. Best, took up the study of American roses, concerning which he has published a number of interesting notes,[5] which deserve to be consulted by all who study the genus.

Thanks to researches and multiplied observations which have been made, the acquaintance with a certain number of species is

[3] Garden and Forest, 1887.

[4] "Nouvelles remarques sur les roses américaines," *ibid.* **26**: —. 1887, and **28**: —. 1889.

[5] Remarks on the group CAROLINÆ of the genus *Rosa*, in *Bull Torr. Bot. Club*, 1887. Remarks on the group CINNAMOMEÆ of the North American Roses, *ibid.* 1890. North American roses; remarks on the characters with classification, in *Jour. Trenton Nat. Hist. Soc.* 1889.

sufficiently complete, and these species are scarcely able to cause confusion, at least to collectors and authors who will take the trouble to consult good descriptions. These species are: *R. setigera* Michx. (*R. rubifolia* R. Br.), *R. Carolina* L., *R. humilis* Marsh. (incl. *R. parviflora* Ehrh. and *R. lucida* Ehrh.), *R. nitida* Willd., *R. foliolosa* Nutt., *R. gymnocarpa* Nutt., and *R. minutifolia* Engelm.

But besides these species there are others less well known, which have frequently given rise to confusion. These latter will be considered especially in the notes sent to the BOTANICAL GAZETTE.

The genus *Rosa* has had the singular fortune of having been studied more than any other genus, and of having had its species become more obscure and less recognizable as the work upon them has multiplied, so that today the study of the genus is dreaded by the great majority of botanists. On account of the chaotic state to which the genus has been reduced by species makers, some students have concluded that there are no established boundaries between the species, and that it is useless to seek for constant characters with which to separate them. For some years I have not ceased to protest against this idea, which is radically false, and contradicts well-observed facts. I will continue to affirm that the true species of the genus *Rosa* are clearly characterized, and as distinct from each other as those of any other genus.

One can attribute the deplorable state of the genus for half a century to two principal causes, *viz.*, the condition of the collected material, and the desire of numerous amateurs and florists to discover a great number of new species in a small territory. In most genera the species are represented in herbaria by individuals more or less numerous all of which usually show the characters necessary for good specific determination, so that one may compare individuals with each other, may distinguish dwarf and giant variations, and may form some adequate conception of the possible modifications by organs due to lack or excess of vigor.

But in *Rosa* this is not the case. The species are represented in herbaria by fragments only, either in flower or in fruit, from which one cannot always obtain all the factors for a just conception. If it had been possible to represent the roses in collections, as has been the case with herbaceous plants, by entire individuals, that is to say by bushes, the recognition of the species would not be in so great uncertainty. To the difficulties resulting from insufficiency of material there are added those which the species makers have accumulated, the "counters of hairs," as they are sometimes called, who have multiplied specific types in a needless fashion.

It is to warn my American confrères against the breaking up of species, and to show them how careful one must be before proposing a new type, that I intend to submit to them some considerations based upon long experience, taking up especially species of the section CINNAMOMEÆ.

Each species may present itself in three conditions of vegetation: an habitual state, which may be called the medium, a dwarf state, and a giant state. It is from the medium state, that is, the most frequent one, that the description of the type is usually drawn. The distinctive characters furnished by this state are put in relief in the diagnoses. The dwarf and giant states, however, present certain characters which do not correspond to these diagnoses, and lead to an inference of the existence of specific forms distinct from those described. This has frequently occurred. The dwarfing or the enlargement in the genus *Rosa* affects the form of the prickles, the dimensions of the leaves, of the flowers, of the fruits, etc.; affecting not only the *ensemble* of a bush, but also different parts of the same bush. Thus a delicate or more or less exhausted axis may give rise to puny floriferous branches with small leaflets and single-flowered inflorescences; while a vigorous axis may give rise to floriferous branches with large leaflets and many-flowered inflorescences. These two kinds of branches, if they be isolated, appear very different from each other, and may give rise to the idea of two varieties or even of two species. It is the dwarfing or enlarge-

ment occurring upon a single bush, however, which deserves special study.

In the section CINNAMOMEÆ the armature of the axes shows three conditions: (1) all the axes may be covered with setaceous prickles, scattered and more or less abundant; (2) scattered prickles may occur only in the lower parts of the axes, being completely wanting in the upper parts, which thus become unarmed; (3) prickles may be borne, as before, upon the lower parts and disappear in the upper parts, where the armature is reduced to the regularly paired prickles upon each leaf. It may happen that in species normally provided with paired prickles, these may not be produced upon certain floriferous branches, as also at the extremity of the stems.

In the first case, in which the axes are completely setigerous, dwarfing has apparently no influence upon the armature; but enlarging produces a diminution in the number of prickles at the extremity of the axes. In the second case, dwarfing produces the appearance of numerous prickles distributed equally over all the axes; while enlarging increases the unarmed appearance. Lastly, in the third case, dwarfing produces the development of numerous prickles equally distributed upon those parts of the axes which are normally without them and introduces an obstacle to the regular arrangement of the paired prickles; while enlarging favors the occurrence of paired prickles upon the extremity of the axis.

These variations in the armature result in specimens of the same species differing much from one another, according as they have been taken from the dwarf or giant bushes, or from the lower or upper parts of the same bush.

Again, dwarfing may produce the curious result of transforming the main stem into flower-bearing branches. These stems, remaining dwarf, instead of terminating in a leaf bud which continues the axis, end in an inflorescence which is more or less many-flowered. These stems are thus transformed into floriferous branches, differing in appearance from the normal floriferous branches, and showing one or two more pairs of leaf-

lets, with leaves and upper stipules more crowded. It is this exceptional state of growth which seems to me to have suggested the establishment of *R. Arkansana* Porter.

In Europe, the pubescence and glandulosity have played a preponderant and excessive part in the separation of species and have led to the establishment of a host of pretended species. These have encumbered the genus to such an extent, that it has become nearly impossible to study it. I do not intend to rule out entirely pubescence and glandulosity as means of distinguishing species, but it is necessary to abandon the idea of using them as distinguishing characters of the first order, and to limit their use to indicating differences of a very secondary value. Many species may be either glabrous or pubescent, glandular or non-glandular; but some are more frequently glabrous, others more frequently pubescent, or more habitually glandular, or more often non-glandular. Finally, there are some species which are glandular with great constancy.

What has just been said with reference to smoothness and pubescence, and a glandular and non-glandular condition, is applicable to the form of the leaf-teeth as well, which in the same species may be simple, double, or glandular-compound.

The form of the floriferous and fructiferous receptacles is also subject to frequent variation in the same species. Certain species, however, have the receptacles habitually rounded, while others have them more or less ovoid or elongated. In the section CINNAMOMEÆ the rounded form is the most common.

An attentive study of the numerous variant forms displayed by different species reveals parallel lines of variation, which are faithfully repeated in the different species. The existence of these parallel variations strengthens the evidence as to the folly of an excessive multiplication of species. I wish to say, in passing, that the fragmentation of species of *Rosa* has had in America an exponent in Rafinesque. This singular naturalist, whom one should never take seriously, has constructed some species which will remain enigmas forever.

In Europe the recognition of true species was retarded for a

long time by the ignorance concerning the existence of hybrids, whose intermediate and vacillating characters often render obscure those of genuine types. At present, however, since the frequent occurrence of hybrids has been demonstrated and the bastard products partly classified, the distinction of species has become more precise and rigorous. It is probably true that American roses do not escape hybridization any more than the European and Asiatic species, and the American botanists must face the duty of discovering the hybrids of their country, for their first recognition ordinarily cannot be made with certainty except in the field. They will have to examine with much attention the more or less intermediate forms which occur where several species grow in company. Perhaps they will discover hybrids between *R. pisocarpa* and *R. Nutkana*, between *R. pisocarpa* and *R. gymnocarpa*, between *R. blanda* and *R. acicularis*, etc. M. Th. A. Brutsin has described a *R. neglecta*, which he considers *R. lucida* × *blanda*.[6] Up to the present, in such herbarium material as I have studied, I have recognized but one form which has seemed to me a hybrid, a form which seems to be *R. Carolina* × *humilis*.

I herewith close this preamble, which may appear long, but which I thought indispensable to enable my American confrères to understand thoroughly my way of looking upon species of the genus *Rosa*.

BRUSSELS, March 5, 1896.

ROSA NUTKANA Presl.

I begin my remarks with this species because it has just been the object of a new specific creation under the name of *R. Macdougali* Holzinger.[7] The description of this supposed new species given by Mr. Holzinger is entirely insufficient, and does not permit even the section to be recognized. Two beautiful specimens that Mr. Coville has kindly sent me[8] have enabled

[6] Vergleichende Flora Wisconsin in *Verhand. d. K. K. Zool.-bot. Gesell. in Wien* 26: 246. 1877.

[7] BOTANICAL GAZETTE 21: 36. 1896.

[8] Mr. Coville has also sent to me specimens of *R. blanda*, *R. Fendleri*, *R. Cali-*

me to recognize the plant. It is a variety of *R. Nutkana*, with twigs and floriferous branchlets unarmed (in my two specimens), leaflets pubescent on the principal veins, simple teeth, one-flowered inflorescence, hispid-glandular pedicels, receptacles beset with numerous glandular hairs, and sepals glandular on the back. The author says that the single character of hispid-glandular receptacles permits his new species to be distinguished from all other American types. However, several other American species may have their receptacles as hispid as that of *R. Macdougali*. If Mr. Holzinger had consulted the BOTANICAL GAZETTE of 1894 he would have found that Mr. Merritt Lyndon Fernald had described (p. 335) a variety of *R. Nutkana*, under the name of *hispida*, whose receptacles are strongly hispid-glandular. This variety *hispida* was established upon specimens received by Watson from Rock Creek, Montana, and through C. V. Piper from Pullman, Washington. In 1885 Watson in his monograph alluded to the Rock Creek plant, and was inclined to consider it a variety of *R. Nutkana*. Does the variety *hispida* have leaflets glandular beneath and glandular-compound teeth? I have reason to suppose that it has. In 1890, Mr. Edward L. Greene sent me some undetermined specimens which had been collected at Lake Pend d'Oreille, which proved to be a variety of *R. Nutkana* probably identical with the var. *hispida*. The leaves have become almost glabrous, but are glandular beneath, with glandular-compound teeth, and the pedicels, receptacles and sepals are densely hispid-glandular. In my *Prodromus* of 1876 I have given a history of *R. Nutkana*, which at that time was poorly known. Afterwards, the rich material which I have brought together, and the study which I have made of the plant in cultivation, make me somewhat acquainted with the different variations of this type. They are numerous, and can be grouped in several series, which are parallel with the series of variations produced by other species of the same section. These series

fornica, and *R. gymnocarpa*, cited by Mr. Holzinger in his "Report on a collection of plants made by J. H. Sandberg and assistants in northern Idaho in the year 1892," in Contributions from the U. S. National Herbarium 3:223. 1895.

show us glabrous or pubescent leaves, simple or glandular-compound leaf-teeth, leaves glandular or non-glandular beneath, and the floral organs smooth or hispid-glandular.

Instead of describing at length all these variations, a work reserved perhaps for a monograph, in would seem best to present the characters proposed to distinguish *R. Nutkana* from the neighboring species.

I shall compare it first with *R. blanda*, which it resembles in certain features. The armature, when it is normally developed, is sufficient alone to distinguish the two types. Both, as is the case habitually among the CINNAMOMEÆ, bear numerous ordinarily setaceous[9] prickles below, but in *R. Nutkana* these prickles are accompanied by stouter prickles regularly paired on the leaves, prickles which are entirely lacking in *R. blanda*. The paired prickles of *R. Nutkana*, on the stems especially, are very peculiar and very different from the prickles of other American species of this section, often being thick, triangular in form, and more or less decurrent at base, normally straight and perpendicular to the axis from which they arise. On the branches these paired prickles become less robust, and likewise on the floriferous branches. Watson describes the prickles of *R. Nutkana* as being decurved, and Best says the same. I have examined sufficient material, both wild and cultivated, to be well assured that the prickles belong to the straight type, only exceptionally becoming decurved and hooked, as is the case in European and Asiatic species with prickles of the straight type. But the decurving is simply an accident, and it is this accident which Watson and Best saw. Prickles normally curved and hooked apparently occur in but one American species of the section CINNAMOMEÆ, namely, *R. Californica*.

The paired prickles also distinguish *R. Nutkana* from *R. blanda*, which is absolutely free from them. But if for some reason the paired prickles disappear from certain parts of the axes, it is then necessary to have recourse to other distinctions. Such are

[9] In the variety of *R. Nutkana* which I formerly called *R. Durandii* the setaceous spines are often replaced by pedicellate glands.

not wanting, but they are not as easy of application as those drawn from the prickles. The form of the leaflets, perhaps, may be usefully employed. In *R. Nutkana* the leaflets are oval, more or less rounded at base, with teeth rather open; while those of *R. blanda* are obovate, relatively narrower, more or less attenuate at base, with teeth turned towards the apex. It can be added that the former frequently has glandular-compound teeth, while the latter almost always has simple ones. To judge well the differences I have described it is necessary to compare quite an amount of material of the two species, for fear of being deceived by certain variations of form.

The inflorescence can also be used for a distinction, but should be used only with sufficient material for accurate judgment. The inflorescences of *R. Nutkana* are much more often one-flowered than are those of *R. blanda*. The statistics which I have obtained concerning the inflorescences give the following proportions between the one-flowered and many-flowered inflorescences: for *R. nutkana*, 1.8:1; for *R. blanda*, 1:1.4.[10]

The corolla is notably larger in *R. Nutkana*, and the fructiferous receptacles and akenes are a little larger. The tissue of the fructiferous receptacle at complete maturity is drier and less pulpy than in *R. blanda*. I wish to remark, in passing, that the size of the akenes, from which Mr. Best has obtained the means of distinguishing *R. Carolina* from *R. humilis*, deserves the attention of American botanists. In the section CINNAMOMEÆ it will be found probably that the size of the akenes may be usefully employed as a distinguishing character.

The upper stipules and bracts are habitually much more dilated in *R. Nutkana* than in *R. blanda*.

All of these last characters, resting simply upon a difference in size, certainly are of importance, but unfortunately they very often weary the perplexed observer who cannot compare a sufficient amount of well chosen material.

R. pisocarpa and *R. Californica* have paired prickles, as in *R. Nutkana*. In the former, these prickles, which are straight, are

[10] *Cf.* Remarques sur l'inflorescence des Rosa in *Bull. Soc. bot. Belg.* **34**[2]:—. 1895.

slender and never take the form, at least on the stems and principal branches, of the stout prickles of *R. Nutkana*. In the latter, the paired prickles are more or less curved or hooked, and only exceptionally on the slender axes do they become more or less straight. I shall consider later other characters which separate *R. pisocarpa* and *R. Californica* from *R. Nutkana*.

Let us examine at present the geographical distinction of the latter. In his monograph, Watson says that it occurs along the Pacific coast from Alaska, in 62° lat., to Oregon, and extends eastward into the mountains of Idaho and northern Utah, where the Wahsatch marks its limit. Including the variety *hispida*, its eastern limit is extended into western Montana. From material which I have received, I have recognized the species beyond the limits of the United States in Vancouver island, in the lower valley of the Fraser, along the upper Columbia, also in Alberta. I have received specimens from the island of Sitka, which appear to me to belong to *R. Nutkana*. The material from the island Kodiak, which I have described under the name of *R. Aleutensis*, perhaps is, as Watson thought, a variety of the type of Presl, but before accepting this identification fresh investigation must be made.

Upon this side of the frontiers of the Dominion the species occurs in Washington and Oregon between the Pacific coast and the Rocky mountains. Does it reach California or Nevada? It occurs in the Siskiyou mountains, at the boundary of Oregon and California. Towards the east it extends to the mountains of Idaho and Montana. It is not very rare in Utah in the Great Salt Lake region, from which I have received specimens collected by Jones. In these localities it occurs at an altitude of 8,000 feet. Mr. Porter has sent me two floriferous branches collected by Mr. John Scott, in 1869, in the mountains of Colorado. These branches, reported as *R. Woodsii*, seem to me to belong to *R. Nutkana*. It is altogether likely that the species will be discovered in the mountains of Wyoming. According to the known facts, therefore, *R. Nutkana* has a boreo-occidental distribution.

ROSA BLANDA Ait.

According to Watson, *R. blanda* extends from Newfoundland to Hudson's Bay, and southward to northern New York, whence it extends to the west as far as Minnesota, traversing Ontario, Michigan, Illinois, and Wisconsin, and appearing again to the north in Manitoba. We have in this a boreo-oriental distribution. In the consideration of *R. Arkansana* a little later we shall see whether this western limit of *R. blanda* should not be extended. Recently, Mr. Holzinger (*loc. cit.*) has pointed out *R. blanda* as occurring in Idaho (valley of Little Potlatch river, no. 381; Lake Cœur d'Alene, no. 581), but no. 581 of the Sandberg collection, of which I have received a beautiful specimen, appears to me to belong well to *R. Nutkana*. Its prickles are paired, its leaflets are pubescent and with simple teeth, its pedicels are ordinarily hispid-glandular, and its sepals are glandular without. As for no. 381 of the same collection, there is not the least doubt that it is *R. Nutkana*, with pubescent leaflets and simple teeth, and pedicels, receptacles and sepals smooth. The corolla is very large.

R. blanda, which often has pubescent leaves, sometimes displays leaves perfectly glabrous; the teeth are almost always simple, and very rarely do they become glandular-compound. Rarely, also, are the leaves a little glandular beneath, and the receptacles hispid-glandular. Different ages may give rise to various series of variations.

ROSA ARKANSANA Porter.

In my *Nouvelles remarques sur les roses américaines* (1889) I have discussed at length the value of *R. Arkansana*, which I had concluded to consider only a variety of *R. blanda*.

According to the terms of the original description, the name *R. Arkansana* can strictly apply only to the form producing simple stems crowned with a terminal inflorescence. These simple stems, about a foot high, are more or less clothed with scattered, slender, straight and often setaceous prickles; the leaves, which are really cauline leaves, have four or five pairs of leaflets; and the

exterior sepals sometimes bear lateral appendages. The authentic specimens whieh I have received from Mr. Porter have glabrous leaves.

Under the name *R. Arkansana*, Watson has not well included the preceding form, which alone constitutes *R. Arkansana* as it had been described by Mr. Porter, but applies it to tall forms, with stems attaining six feet in height and bearing floriferous branchlets which arise directly from the stem or are borne on the branches.

According to the abundant material which I have brought together in my herbarium under the name *R. Arkansana*, this species does not always have simple stems terminated by a many-flowered inflorescence and more or less setigerous. It may give rise to stems more or less tall and branching. In this case, the entire stem perhaps is clothed with numerous setaceous prickles which completely cover it or the greater part of the floriferous branchlets, which are then as setigerous as those of *R. acicularis*. It remains to be seen whether *R. Arkansana* in the dwarf state or in the tall bushy state may not be sometimes completely unarmed, with its floriferous branchlets entirely bare of prickles as are the upper branches. I have reason to think so. But in the last case what remains to distinguish *R. Arkansana* from *R. blanda?* Nothing seems to remain, for when the former produces floriferous branchlets upon the stem of the second year, or on the branches, these floriferous branchlets do not have four or five pairs of leaflets as in the false floriferous branchlets of *R. Arkansana* as constituted by Mr. Porter, but leaves of only five or seven leaflets, as those of *R. blanda;* and, on the other hand, I do not see any difference between the normal branches of the two species. Perhaps it can be claimed that in *R. Arkansana* the exterior sepals are a little less rarely appendaged than in *R. blanda.*

It appears, then, that between these two roses there is a simple difference in the degree of abundance of prickles. The leaflets are the same, either glabrous or pubescent, and the floral organs appear to be identical.

Despite the extremely close affinity of these two forms, I think

it prudent to obtain additional information before uniting them. Therefore in the dichotomous table at the end of this paper I have separated *R. Arkansana* as a distinct species, for the purpose of facilitating investigation. It is especially necessary to examine the mode of vegetation of *R. Arkansana*, and to discover the modifications involved in dwarf and giant forms. The cause of the dwarfing, which is quite frequent, should be investigated. Perhaps the frequent fires which ravage the prairie region where *R. Arkansana* appears to occur may have some connection with the dwarfing. It is important to know whether *R. blanda*, more or less typical, does not occur quite frequently associated with *R. Arkansana*, and whether the latter does not gradually pass into the former by a series of intermediate states.

I have specimens of typical *R. Arkansana* from Minnesota, Nebraska, Kansas, Colorado, and Manitoba, and from the Saskatchewan. I have described the plant from the last station under the name *R. blanda* var. *setigera*.

Finally, if *R. Arkansana* is found to be a variety of *R. blanda*, the area of distribution of the latter will be extended chiefly westward.

ROSA PISOCARPA A. Gray.

In 1876 (*Prodromus*) I expressed doubts as to the autonomy of *R. pisocarpa* A. Gray. These doubts have been removed by subsequent study of abundant material received from America, and from cultures which I have made. Before entering into the discussion, I wish to remark that Nuttall, who first had recognized the character of *R. gymnocarpa* and *R. foliolosa*, and likewise of *R. Nutkana*, which he had designated in his herbarium as *R. megacarpa*, had taken *R. pisocarpa* for a new species, to which he gave the name *R. arguta* MS. If Torrey and Gray had retained these two names proposed by Nuttall, there would have been two more species to his credit.

In its habitual form, such as Asa Gray described and figured in the *Botanical Magazine* (*pl. 6857*), *R. pisocarpa* cannot be confounded with any other species. Its prickles regularly paired, and its leaflets more or less conspicuously rounded at base, dis-

tinguish it from *R. blanda*. Its slender and straight prickles, and its inflorescence with small and usually numerous flowers, separate it from *R. Nutkana*. Lastly, the form of its prickles, which are straight and not curved or hooked at the tip, permits no confusion with *R. Californica*.

Despite these differences, there is more or less confusion. Thus, specimens of *R. pisocarpa* received from the Siskiyou mountains, Washington, from Mr. Pringle and Mr. Suksdorf, have been reported by Watson as *R. Californica*. This error came from the appearance of the specimens and a too narrow conception of *R. pisocarpa*. They do not always show the small rounded fructiferous receptacles as large as a pea, such as were described by Asa Gray. These receptacles can become notably larger, either strongly constricted at the neck, or ellipsoidal. On the other hand, the leaflets, which are glabrous or pubescent, sometimes show small glands upon the lower surface. In the last case, the teeth either remain simple or become glandular-compound. Among the rich material from Washington sent to me by Mr. Suksdorf, and which I have placed in my herbarium under *R. pisocarpa*, there are forms whose leaflets are more or less attenuate at base, as in *R. blanda*, instead of rounded as in the type. Will the contraction of the lower part of the leaflets necessitate the making of a species distinct from *R. pisocarpa?* This is impossible, for this difference is not to be regarded. Such contraction will always weaken the amount of distinctive characters which separate *R. pisocarpa* and *R. blanda*.

R. pisocarpa seems to be subject to the same variations as are *R. Nutkana* and *R. blanda* from dwarfing and enlarging, and to show very marked differences between specimens from dwarf bushes and those from more vigorous and taller bushes.

The geographical range given to *R. pisocarpa* by Watson seems to me to need extension, and that, too, probably at the expense of the two groups of forms which he has included under the names *R. Fendleri* and *R. Woodsii*. Towards the north Watson does not extend the limit beyond the southern part of British Columbia. Does the species occur farther north? I am

inclined to believe so. Mr. Greene has sent me a small flowering specimen collected by Mr. Bates, in 1882, near Fort Yukon, Alaska, which seems to me to belong to *R. pisocarpa*. However, I do not wish to announce this determination with certainty; but I am certain that it is not *R. acicularis*, which Watson cites from the same locality.

R. pisocarpa passes down the Columbia into Washington and Oregon, penetrates California in the Sacramento valley, and, I am well assured, reaches Nevada City.

It now remains to see whether it does not extend towards the east and south by the Rocky mountain range, as is the case with *R. Nutkana*. In Idaho Mr. Sandberg has collected, on the shores of Lake Pend d'Oreille (no. 871), a form reported by Mr. Holzinger as *R. Californica*, which appears to me to be a variety of *R. pisocarpa*, the same as two other forms obtained by the same collector in Montana (no. 973 and no. 1009) and reported by Mr. Holzinger as *R. Fendleri*. Mr. Greene, also, has obtained from Idaho, near Montpelier, a form which I think should be referred to *R. pisocarpa*. I have from Utah different forms collected by Mr. Jones, among which I think I recognize the type of Gray. Lastly, from Colorado I have received several roses whose specific identity, for want of sufficient material, is perplexing to me; nevertheless I have reason to suppose that *R. pisocarpa* is among them. These forms of Utah and of Colorado for the most part have been referred by Watson to *R. Fendleri* and *R. Woodsii*.

Rosa Fendleri Crépin.

I have given the name *R. Fendleri* to a rose obtained by Fendler in New Mexico. Watson has described under this name plants from a great number of localities, and upon considering the description given in his monograph and the extent of the geographical distribution, one is tempted to believe that he has characterized a good species; but despite long study I am unable to form a clear idea of that specific group. I am tempted to believe that *R. Fendleri* as constituted by Watson is probably an

artificial group formed, in part, at the expense of *R. pisocarpa* and *R. blanda*, and perhaps partly of one or of several other species as yet incompletely known. As for my *R. Fendleri* of New Mexico I have examined too little material to be actually sure that it is an autonomous type.

For elucidating the problem of *R. Fendleri* a number of investigations need to be made. The botanists who explore the vast region of the Rocky mountains should make careful observations as to the appearance of the bushes. They should examine the variations which accompany the dwarf and giant states, and obtain abundant, well-selected material from which to form a trustworthy opinion of the armature of the different axes. In short, in my opinion, *R. Fendleri* remains as an obscure species, not capable of being clearly defined in the dichotomous table which I have added at the close of the paper.

Rosa Woodsii Lindl.

R. Woodsii was established upon a plant cultivated in the Garden of the Horticultural Society of London. It was supposed to have come from the basin of the Missouri. I have authentic specimens in my herbarium, and have seen others in the Lindley herbarium. One perceives how much cultivation ordinarily modifies the appearance of a species, and how much a description drawn from a single cultivated plant can introduce uncertainty when there is an attempt to apply such a description to the wild plant. This is certainly the case with the description of *R. Woodsii*.

I here wish to digress a moment in reference to this. Watson established, within the Cinnamomeæ which he described, two principal divisions. The first is characterized by the prickles all scattered, and includes *R. acicularis*, *R. Sayi*, *R. blanda*, and *R. Arkansana*; the second is distinguished by the paired prickles, and includes *R. Nutkana*, *R. pisocarpa*, *R. Californica*, *R. Fendleri*, and *R. Woodsii*. This last division is subdivided into two groups, one of which has the sepals all entire, and the other with the outer sepals ordinarily having one or several lateral segments. The

last includes only *R. Woodsii*. Certainly the form of the sepals is extremely important in distinguishing species and even sections, but it is necessary that that form be normal and constant. Now in the section CINNAMOMEÆ the sepals are normally entire, and it is only exceptionally that they produce toward the summit small entire and erect appendages. The difference is great between these sepals exceptionally appendaged and those normally producing lateral appendages from the base. It should be mentioned that the exceptional appearance of lateral appendages is not peculiar to *R. Woodsii*, but may occur in almost all of other American CINNAMOMEÆ.

It follows, therefore, that the most distinctive character used by Watson to sustain the autonomy of *R. Woodsii* has no value, or at least a very secondary value. What other characters, therefore, can separate this species from its neighbors? I have not been able to discover them. In 1876 I expressed the opinion that *R. Woodsii* was only a variety of *R. blanda*. Today I would not dare to be so positive, and would reserve my judgment concerning this form. New researches are necessary either to merge it with another species or to establish it as distinct.

The original description of *R. Woodsii* was corrected by Lindley himself in the *Botanical Register* **12**, which contains a beautiful figure of it (*pl. 976*). This figure, drawn from the cultivated plant, of which I have specimens, has glabrous leaflets oboval and attenuate at base as those of *R blanda*, and with simple teeth; perfectly entire sepals, although in my specimens the exterior ones are sometimes laterally appendaged; receptacles sensibly larger than in these same specimens; and lastly, prickles quite regularly paired as well upon the branches as upon the floriferous branchlets, while in my specimens they are generally scattered and paired only beneath a few leaves terminating the branches. Lindley, in his original description, says the prickles are scattered, but become paired toward the "extremities." By "extremities" he doubtless meant the summit of the main branches or leaf-bearing branches. In the corrected description of the *Botanical Register* he declares that they are

scattered. It is important to know whether the prickles are normally scattered or paired, for, in the former case it would make *R. Woodsii* approach *R. blanda*, while in the latter case it would approach *R. pisocarpa*. This observation must be made in the Missouri region, which appears to be the natural habitat of *R. Woodsii*.

Watson identifies *R. Maximiliana* Nees as *R. Woodsii*. I have authentic specimens of that rose obtained by Prince Max. von Wied in the prairies on the banks of the Missouri. Apart from its pubescent leaflets that form shows very close affinity to *R. Woodsii*, with which it certainly seems to be identical. The armature of its axes very much resembles that of specimens of *R. Woodsii* to which I have alluded above, and leaves me without doubt as to the arrangement of the prickles.

In conclusion, *R. Woodsii* of Lindley remains doubtful to me. Perhaps it constitutes a distinct species; perhaps it is but a variety of *R. blanda* or of *R. pisocarpa*. In reference to *R. Woodsii* as constituted by Watson, I believe it is composed of heterogeneous specific elements.

Rosa gratissima Greene.

Mr. Greene described his *R. gratissima* in 1891 in his *Flora Franciscana*, and remarks that it has the look of *R. Californica*. According to Mr. Greene the prickles, which are slender and straight, are paired only upon the vigorous growing shoots.

Upon comparing the descriptions of *R. gratissima* and *R. Californica* given by Mr. Greene, we find that the first is distinguished from the second (1) by its prickles straight and slender, not stout and habitually curved; (2) by its leaves thin and bright green, not firm and dark green, with teeth a little falciform and not open; (3) by the stipules of the cauline leaves strongly denticulate and not entire. From an examination of specimens sent to me by Mr. Greene, undetermined, but with no doubt as to their identity with *R. gratissima*, I would point out (1) that the prickles are slender and straight, abundant and all scattered on two long fragments of stems, less abundant on the

portions of the stem bearing floriferous branchlets where they are also scattered or rarely irregularly paired, also irregularly paired but more often scattered on the floriferous branchlets; (2) that the leaves are thin and bright green, with teeth usually simple and directed somewhat towards the apex; (3) that the stipules of the cauline leaves are quite strongly denticulate, but so also are the upper stipules of the floriferous branchlets and the bracts. But Mr. Greene has not remarked the fact that the upper stipules and bracts are dilated, while those of *R. Californica* remain narrow. This dilatation of stipules and bracts, in my judgment, constitutes an important distinctive character.

I observe, moreover, that the inflorescences are all pluriflorous, with 2 to 5 flowers, that the pedicels are long and slender, quite often a little pubescent, that the pubescence may invade the receptacle, that the sepals may be silky on the back and the exterior ones sometimes furnished above with one or two small very narrow and entire lateral appendages, and, lastly, that the corolla is quite small. Mr. Greene seems to lay stress upon the fragrant glands of the leaves. I would remark, however, that the glandular character of certain varieties of *R. Californica* is more marked and persistent. In *R. gratissima*, as in the forms of *R. pisocarpa* with glandular leaves, the leaf glands are very small, sessile, very abundant on very young leaves and as abundant on the petioles as upon the lower surface of the leaflets; but these glands are fugacious and disappear with age, for the most part quite promptly. In *R. gratissima* these minute glands may also invade the upper surface of the leaflets.

The question suggests itself whether *R. gratissima* constitutes an autonomous specific type, or is an aberrant variety of *R. Californica*. The material which I have received, obtained perhaps from one bush, does not permit me to decide with certainty. Nevertheless, by reason of its dilated upper stipules and bracts, and its straight spines, I consider that *R. gratissima* is specifically distinct from *R. Californica*, and that other characters do not permit it to be a variety of *R. pisocarpa*.

It is important to know whether the character drawn from

the denticulation of the stipules and bracts[11] remains constant on all the bushes or is exceptional. In the second place, an important point to elucidate is the normal disposition of the prickles. Are they normally scattered and only exceptionally paired, or are they regularly paired on bushes more or less vigorous?

If *R. gratissima* constitutes a distinct type, it can be expected to occur with glabrous leaves and glandular-compound leaflet-teeth, and also, perhaps, with pedicels and receptacles hispid-glandular.

Rosa Californica Cham. & Schlecht.

R. Californica is a species which occurs extensively throughout California. It seems to be somewhat common there and plays about the same rôle as does *R. canina* in Europe. It ought, therefore, to produce numerous varieties.

Watson groups *R. Californica* with *R. pisocarpa* and *R. Fendleri* in a subdivision characterized by its small flowers, ordinarily in pluriferous inflorescences, and its short and narrow stipules; while he forms with *R. Nutkana* another subdivision distinguished by its large flowers, ordinarily in one-flowered inflorescences, and its dilated stipules. *R. Nutkana* is well distinguished, indeed, by a large corolla, by inflorescences often one-flowered, and by the upper stipules remarkably dilated; but in *R. pisocarpa* the stipules cannot be said to be altogether narrow, and the upper ones, although smaller than those of *R. Nutkana*, are, nevertheless, more dilated than those of the lower and cauline leaves. The same thing is seen in the forms which Watson has described under *R. Fendleri*. In *R. Californica* all the stipules appear to remain narrow, the upper ones becoming no more dilated than the lower, as is the case in *R. spithamæa*. This would suggest an important distinction to be established between the species with upper stipules and bracts dilated, including *R. Nutkana*, *R. pisocarpa*, *R. gratissima*, *R. Fendleri*, *R. Woodsii*, *R. blanda*, and *R. aciculariss*, and those with upper stipules and bracts remaining narrow, including *R. Californica* and *R. spithamæa*. I would call the

[11] An analogous denture is observed sometimes in *R. blanda* and *R. Arkansana*.

special attention of American botanists to these differences, and urge them to see whether they are constant.

The form of the prickles affords a second important distinctive character for *R. Californica*. In that species alone are the prickles curved at the tip or more or less hooked. Watson does well to assign straight or recurved prickles to *R. Nutkana*, *R. Fendleri*, and *R. Woodsii*, but in those species, in my opinion, prickles recurved at the tip are only exceptional.

It is well to consider the regions of the axes where the prickles habitually show their normal form. These regions are ordinarily situated in the middle part of the stems and branches. On the floriferous branchlets, prickles normally recurved or hooked, following the weakness of the axes, may become straight. These variations in the armature, both in the form of the prickles and their arrangement, explain the necessity of judging only from quite large specimens, and the extreme usefulness of being able to observe the whole bush.

The form of the leaflets seems to vary quite widely in *R. Californica*, as well as the teeth, which may be simple or glandular-compound. The base, however, appears to be almost always rounded, and not attenuate or cuneate. The leaflets are almost always pubescent, with the lower surface glandular or not. According to Watson, they very rarely are completely glabrous, and that author cites but a single case, that of specimens obtained by Palmer at San Bernardino. No. 454 of the Palmer collection, representing *R. Californica* of that locality, is made up of specimens taken from several bushes which do not all belong to the same variety or even to the same species. Some have completely glabrous leaves and straight prickles, while others have pubescent leaves and more or less hooked prickles. Engelmann had sent to me specimens of this last form, also from San Bernardino. If the pubescent specimens belong to *R. Californica*, those with glabrous leaves appear to belong to another species. In my *Prodromus*, I have described a variety *glabra* of *R. Californica*, established on a plant cultivated in the Jardin des Plantes, Paris, under the name *R. myriantha* Decaisne, but that plant can

as well be a variety of *R. pisocarpa* with glabrous leaves, and appears to be identical with the *R. pisocarpa* of Nevada City, to which I have already alluded.

Watson attributes to *R. pisocarpa* and *R. Fendleri* globular fructiferous receptacles, and to *R. Californica* ovoid receptacles narrowed above. Even if in the last the receptacles are almost constantly of that form, they may be sometimes globular, as, on the other hand, those of *R. pisocarpa* and *R. Fendleri*, in their turn, may be ovoid and narrowed above. Despite these variations, perhaps we should retain for these species the characters drawn by Watson from the form of the receptacles.

In comparing the diverse varieties which I include under the name *R. Californica*, with prickles curved or more or less hooked, and upper stipules and bracts narrow, one wonders whether several distinct specific types are not included under it, whose characters are not yet well known. For want of sufficiently abundant material I am compelled to reserve my judgment upon this question. I hope that the botanists of California, understanding the interest that attaches to the elucidation of *R. Californica*, will be willing to send to me numerous specimens of that species, obtained from different parts of their country.

Let us examine now the geographical distribution of the species. Watson says that it is found throughout California, ascending the mountains as far as 6,000 feet altitude; that it had been encountered in Oregon and Washington, and perhaps in British Columbia; and existed in western Nevada and extreme northern Lower California. This range traced by Watson seems to me to be incorrect at several points. The specimens which made him include Oregon and Washington in the range belong to *R. pisocarpa*. As for British Columbia, I believe that it is entirely foreign to *R. Californica*. I have received from Nevada a specimen obtained by Mr. Greene from Reno, in the Sierra Nevada, not far from the California boundary. San Diego is the southernmost point from which I have seen specimens. Perhaps towards the south it extends beyond California into Arizona. I have received from Mr. Greene some flowering specimens

obtained by him on Mt. Bill Williams, which have some resemblance to *R. Californica*, but I do not venture to pronounce with certainty as to their specific identity. It is very likely, from the known facts, that *R. Californica* is a species entirely western, peculiar to California, and having the Sierra Nevada as its eastern limit.

If one should believe Mr. Holzinger (*loc. cit.*) the limit of this species should be extended to Idaho, but no. 173 of the Sandberg collections, reported by that author as *R. Californica*, is *R. Nutkana*, while no. 871 certainly does not belong to *R. Californica*. The specimen which I have received is a vigorous flowering branchlet, with inflorescence 22-flowered. Despite this many-flowered inflorescence and quite a small corolla I am inclined to believe that this specimen is a variety of *R. Nutkana*.

In his *Flora of California* Watson describes a variety of *R. Californica* under the name *ultramontana*. This is passed over in silence in the monograph of the same author, and I do not possess authentic specimens of it. Mr. Jones has distributed, under no. 2455, with the name *R. Californica* var. *ultramontana* Watson, specimens of a form obtained at Salt Lake City, which reasonably agrees with the description of the variety *ultramontana*, but which does not appear in any way to belong to *R. Californica*. It rather seems to be a variety of *R. pisocarpa*.

ROSA SPITHAMÆA Watson.

R. spithamæa was established by Watson in 1880, in his *Flora of California*. Later, in his monograph, he did not maintain the species, but reduced it to a variety of *R. Californica*. Perhaps Watson was influenced by the opinion which I had expressed concerning its establishment as a species.[12] Since 1882 I have received some new specimens of that curious rose, and their examination has induced me to think that it can very well be specifically distinct from *R. Californica*. In the valley of the Trinity river, where Mr. Rattan first discovered it, it is ex-

[12] *Cf.* Note sur les recentes découvertes de roses en Amérique, in *Bull. Soc. bot. Belg.* **21**[2]: 146. 1882.

tremely abundant. That botanist wrote to Dr. Engelmann that he had encountered there thousands of plants, that the shrub was habitually but three or four inches high, and that it was only in fertile and shady places that it attained as much as a foot in height. The species seems to preserve its dwarf habit in other localities from which I have specimens.

This extremely reduced stature does not appear to be due to accidental dwarfing, and is very constant, constituting very probably an essential difference from *R. Californica*, which is habitually quite tall. This difference is further emphasized by the fact that the prickles of the former are almost always slender and belong well to the straight type, that the corolla is smaller, and that the receptacles are prominently hispid-glandular, a thing said to be very rare in *R. Californica*, and which, for my part, I have never yet observed.

It appears to me that in *R. spithamæa* the upper stipules and bracts are narrow as in *R. Californica*. This point, nevertheless, must be verified by more abundant material than I have at my disposal.

In *R. pisocarpa*, *R. blanda*, and *R. acicularis*, the stock produces more or less elongated subterranean shoots, which multiply the plants, and quickly transform a single individual into a colony which increases year after year. This very general mode of vegetative propagation among the CINNAMOMEÆ appears in *R. spithamæa*. Does it occur in *R. Californica*? We should be made sure of it.

In his *Flora Franciscana* Mr. Greene describes *R. spithamæa* as a distinct type, and, by the side of it, he establishes a new type under the name *R. Sonomensis*, which seems to be a very nearly allied form. This new species is about a foot high, and is distinguished from *R. spithamæa* by its stipules with auricles truncate and not acuminate; its leaflets broadly oval or almost orbicular, truncate or slightly cordate at base, and not obovate or elliptical and attenuate at base; its inflorescence usually with more numerous flowers; its floriferous receptacles rounded-pyriform, and not ovoid; and its larger sepals.

Not yet having received authentic specimens of *R. Sonomensis* I can only judge of its value by its description. From a careful examination of the specimens of *R. spithamæa* which have come to me, and among them those which have been obtained from Mr. Greene, I am inclined to think that *R. Sonomensis* is but a variety of Watson's species. The future will show whether my supposition is correct or not.

In my *Prodromus* I have spoken of a rose to which I had once given the name *R. Bridgesii*, and which I have merged with *R. Californica*. That rose which I described, and of which I have seen new specimens from the herbaria of Asa Gray, DeCandolle, and the Jardin des Plantes of Paris, may well be specifically identical with *R. spithamæa*. If its identity is recognized, the name *R. Bridgesii* will have to replace *R. spithamæa*.

R. spithamæa is noted by Watson in northern California, in Trinity county, and in the middle of the state at New Alameda and near San Luis Obispo. Mr. Greene notes it in Yuba county, and his *R. Sonomensis* in Sonoma county. To these localities should be added Fresno county, in the Sierra Nevada, where Engelmann obtained the species in a Sequoia forest. I have a specimen obtained by Cuming, but without indication of locality.

Some specimens from San Luis Obispo, which I have seen in the herbarium of Asa Gray, often show numerous glandular-tipped bristles in the intervals between the pairs of paired prickles. It should be remarked that these bristles also appear (but rarely) in *R. Californica*. There is reason to believe that *R. spithamæa* will be discovered in other localities. Perhaps the species is exclusively Californian.

Rosa acicularis Lindl.

The American *R. acicularis* has been long confused among the varieties of *R. blanda*. Borrer, in 1833, in the first volume of Hooker's *Flora Boreali-Americana*, had been on the point of separating it from *R. blanda*. According to Watson, Schweinitz had described this rose in 1825 under the name of *R. Sayi*. In 1876

(*Prodromus*) I described *R. acicularis* Lindl. under its variety *Bourgeauiana* (*R. Bourgeauiana* Crép. at first).

In his monograph, Watson described an arctic form under the name *R. acicularis* Lindl. taking up a second species under the name *R. Sayi*, to which he referred my variety *Bourgeauiana*. According to this author this second species extends less northward than the first. Under these two names are there really two distinct species? I do not think so. It appears to me almost incontestable that the differences used by Watson to separate his *R. acicularis* from *R. Sayi* are not constant, and hence without true value.

In describing his *R. acicularis* of the arctic zone, he seems to try to bring together as near as possible the American form with the form of the old world in attributing to it leaves of five leaflets, elongated receptacles, leaflets mostly with simple teeth and not glandular beneath, and entire sepals. I have not seen specimens from Alaska, but I have received some obtained from Fort Simpson, along the Pelly River, in 63° lat., and in the upper part of the Liard River, in 60° 30′ lat. These specimens show leaves of five to seven leaflets, leaflets glandular beneath and with glandular-compound teeth, sepals all entire or the exterior ones provided with one or two lateral appendages, and fructiferous receptacles globular or elongated-ovoid. I have reason to suppose that the Alaskan form is not different from those to which I have just alluded. As for *R. Sayi*, to which Watson attributes globular fructiferous receptacles and appendaged exterior sepals, it almost always occurs with entire sepals, and if the receptacles are often globular they are not very rarely oblong-ovoid. It is a variety of *R. Sayi* with elongated receptacles which has served Watson for the establishment of his *R. Engelmanni*.[13]

There is no doubt in my mind that under the names *R. acicularis* Lindl. sec. Wats., *R. Sayi* Schwein., and *R. Engelmanni* Wats. there exists only a single and unique type,

[13] *Cf.* Observations on *Rosa Engelmanni* Watson, in *Bull. Soc. bot. Belg.* **28**[2]: 93-95.

to which I gave the name, as above, of the American *R. acicularis*.

It now remains to examine whether this ought to be merged specifically as a variety of *R. acicularis* of the Old World. As early as 1876 I expressed doubts as to the complete specific identity of these two roses. Today I am not disinclined to separate them from each other, and to consider them as two distinct species, although very closely related. The characters which separate them seem important and constant enough to justify their separation. Thus, the American *R. acicularis* has the average leaves of the floriferous branchlets normally of seven leaflets rather than five; its leaflets almost always, if not always, glandular beneath, with teeth glandular, apparently simple or glandular-compound; while in *R. acicularis* of the Old World the leaves have five leaflets, which are always eglandular beneath and with simple teeth. Besides, in the American rose the auricles of the upper stipules are not so long and of a little different form, the inflorescences are less rarely pluriflorous, and the receptacles are habitually less elongated. It is probable that a more searching study will reveal other distinctive characters.

Whether this is the case, is a problem which ought to exercise the sagacity of rhodologists. If the distinction proposed is confirmed, the name *R. acicularis* Lindl. should be retained for the Old World plant, and the American *R. acicularis* should take the name *R. Sayi*, provided the description of Schweinitz applies, as Watson thought, to the rose in question.

Another question to consider is the distinction between the American *R. acicularis* and *R. blanda* and *R. Arkansana*. There are certainly some essential differences between the first and the other two, but these differences sometimes are not such as to make confusion impossible, especially when *R. blanda* and *R. Arkansana* become very setigerous. In the American *R. acicularis* all the axes, from the stem to the floriferous branchlets, are covered with abundant setaceous prickles or bristles. In *R. blanda* it is habitually only the lower part of the stem which is setigerous, the branches and the floriferous branchlets being

unarmed. In this case it is easy to distinguish the two species; but if *R. blanda* increases its armature by extending it to the middle regions of the bush, and even to certain floriferous branchlets; or one finds *R. Arkansana* with axes completely setigerous, then recourse must be had to other characters. Those taken from the leaves are most practical. The leaves of *R. acicularis* are oval, rounded at base, almost always glandular beneath, with open teeth, margins glandular-denticulate or provided with glands; while those of *R. blanda* and *R. Arkansana* are oboval, relatively narrower, quite strongly attenuate or cuneate at base, very rarely glandular beneath, with teeth almost always perfectly simple and directed towards the apex. The form of the stipules is a little different in *R. acicularis*. The inflorescences are much more frequently one-flowered in *R. acicularis* than in *R. blanda* and *R. Arkansana*. The statistics that I have obtained show that the one-flowered inflorescences are to the many-flowered inflorescences as 3.4 to 1 in *R. acicularis;* while in *R. blanda* they are as 1 to 1.4, and in *R. Arkansana* as 1 to 1.6. Lastly, the fructiferous pedicels of *R. acicularis* are more slender, less rigid, and often have a tendency to become incurved, instead of remaining straight.

As to its geographical range the American *R. acicularis* occupies a very considerable area. In latitude it extends from the neighborhood of the polar circle to 38° in the Rocky mountains of Colorado. In longitude it embraces almost all of the continent within the Dominion. To the south it has been observed in Michigan, Wisconsin on the borders of Lake Michigan, and in Minnesota on the borders of Lake Superior. I have received specimens obtained by Messrs. Greene and Kelsey from Helena, Montana, and by Mr. Coulter from the Teton region in Idaho. It is likely that it exists here and there in the Rocky mountains from the borders of Canada to Colorado, where it does not appear to be very rare. As yet there is no indication of it in Oregon and Washington, or in Vancouver Island.

In the Old World *R. acicularis* extends perhaps farther north, but it extends less towards the south than in America.

ROSA GYMNOCARPA Nutt.

R. gymnocarpa Nutt. presents an appearance and distinctive characters which never permit it to be confused with any other American species. Its stem, branches, and floriferous branchlets are habitually clothed with scattered prickles which are very slender, setaceous and very numerous; only in rare cases are the branches and branchlets entirely unarmed. In vigorous and slender bushes, at the extremity of the axes the prickles become more sparse and beneath some leaves appear more or less regularly paired; but that is a simple accident which may happen in the other CINNAMOMEÆ with normally scattered prickles.

Its leaflets are remarkably thin, with teeth richly glandular-compound, the lower surface glabrous and the midrib with quite large glands, which very rarely extend to some of the lateral veins. As to their form and dimensions, the leaflets are very variable; they are very small or quite large, elliptical, oval-elliptical, oval, or oval-suborbicular; the base is often rounded, and quite rarely attenuate.

Watson has described, under the name of variety *pubescens*, some specimens obtained in the Sierra Nevada by Asa Gray, and in Silver mountains by Brewer. It is really that form with finely pubescent leaves. Does it appear specifically distinct from *R. gymnocarpa?* Not having seen it I am not able to express a competent opinion upon it, as upon another form observed by Watson in Montana with corolla two inches in diameter instead of very small.

In *R. gymnocarpa* the inflorescences are habitually one-flowered, rarely many-flowered. The corolla is remarkably small, its diameter not exceeding 20^{mm}. The very slender pedicels are often glandular-hispid, more rarely smooth.

As yet I have always seen the receptacles smooth, but they may be expected to be sometimes glandular-hispid. The fructiferous ones are generally very small, habitually ovoid, rarely globular, and produce a very small number of akenes.

This species presents a character peculiar to it, at least in America. The receptacles, before complete maturity, are cut off

by an articulation towards the summit, permitting the calyx to detach itself in one piece, leaving the receptacular cavity open. This singular articulation, which is constant, also occurs in two Asiatic species of the same section of CINNAMOMEÆ, *R. Beggeriana* Schrenk and *R. Alberti* Regel.

Watson includes in the geographical range of *R. gymnocarpa* British Columbia, Washington and Oregon, and all of California to the latitude of Monterey. He expresses doubt as to the existence of the species as far south as San Diego. Lastly, he also includes in the range northern Idaho and northwestern Montana. With the exception of Montana I have received numerous specimens representing the different regions cited by Watson. The northernmost station from which I have received specimens is situated in 55° lat. These were obtained by Mr. Meehan. I should add, in passing, that I can confirm the exactness of the mention by Mr. Holzinger (*loc. cit.*) concerning northern Idaho. According to the facts thus far recorded the distribution of *R. gymnocarpa* appears to be occidental, and does not extend very much towards the east.

As can be seen from the above remarks, there remain many researches to be made and points to be established before arriving at a complete acquaintance with the genus *Rosa* of western North America. When it is known how much research the roses of the Alps have demanded, it should be expected that the immense extent of the Sierras and Rocky mountains would in their turn demand an equal amount of investigation.

It is reasonable to suppose that these American regions have not yet disclosed all their rhodological riches; and that there will be discovered there unpublished types. Perhaps many such are already in herbaria, but confused as varieties of species already known.

Among the readers of the above paper who desire to cooperate in the work to which I urge American botanists perhaps there may be found those who shrink from the task of extracting from my notes anything essential or practical for the distinction

of species. For their benefit I have prepared an analytical key or dichotomous table. In it I will not include species of the section CAROLINÆ, or *R. setigera* Michx., which belongs to the section SYNSTYLÆ. I will confine myself to the CINNAMOMEÆ, including with them *R. minutifolia* Engelm., from Lower California, which constitutes by itself the monotypic section MINUTIFOLIÆ.

ANALYTICAL KEY TO THE ROSES OF THE WESTERN STATES.

1 Inflorescences always one-flowered, without bracts; exterior sepals appendiculate from the base, with the appendages incised or denticulate; leaflets incised; receptacles with long silky pubescence - - - - - - *R. minutifolia* Engelm

Inflorescences one or many-flowered; pedicels with one or more bracts; exterior sepals entire or with one or two small entire and erect appendages at the summit; leaflets toothed; receptacles smooth or clothed with pedicellate glands - - 2

2 Flowering branchlets more or less setigerous, with scattered setaceous prickles - - - - - - - - - - - 3

Flowering branchlets unarmed - - - - - - - 7

Flowering branchlets with regularly paired prickles under the leaves - - - - - - - - - - - - 11

3 Corolla very small (15 to 20^{mm} in diameter); calyx detaching itself in a single piece during ripening, leaving the receptacles open at summit; akenes not very numerous; leaflets thin, glabrous, with glandular compound teeth - *R. gymnocarpa* Nutt.

Corolla usually much exceeding 20^{mm} in diameter; sepals erect upon the fructiferous and persistent receptacles - - 4

4 Inflorescences ordinarily one-flowered; leaflets oval, broadly rounded at base, with glandular compound teeth *R. acicularis* Lindl.

Inflorescences usually many-flowered; leaflets often more or less attenuate at base, with teeth usually simple - - - - 5

5 Corolla rather small (about 30^{mm} in diameter); leaflets oval-elliptic; sepals silky outside; stipules and bracts strongly denticulate - - - - - - - *R. gratissima* Greene

Corolla rather large; leaflets obovate, strongly narrowed or cuneate at base; bracts usually entire - - - - - - - 6

6 Annual stems often transformed into false flower-bearing branchlets with leaves 9 to 11-foliate, or normal flowering branchlets densely setigerous - - - - - *R. Arkansana* Porter

Annual stems not transformed into false flower-bearing branchlets; normal flowering branchlets with prickles more or less rare *R. blanda* Ait.

7 Corolla very small (15 to 20^{mm} in diameter); calyx detaching itself in a single piece during ripening, leaving the receptacle open at summit - - - - - *R. gymnocarpa* Nutt.

Corolla more than 20^{mm} in diameter; sepals erect upon the fructiferous and persistent receptacles - - - 8

8 Upper stipules and bracts narrow; sepals usually silky outside, *R. Californica* Cham. & Schlecht.

Upper stipules and bracts more or less large; sepals not silky 9

9 Upper stipules and bracts much dilated; inflorescences often one-flowered; corolla usually large; fructiferous receptacles large, remaining quite dry at maturity, with large akenes; leaflets often glandular beneath and with glandular compound teeth *R. Nutkana* Presl

Upper stipules and bracts moderately dilated; inflorescences often many-flowered; corolla quite small or middle-sized; fructiferous receptacles small or middle-sized; leaflets usually without glands beneath, and with simple teeth - - - 10

10 Leaflets oval, more or less rounded at base, with open teeth; fructiferous receptacles often small; corolla quite small *R. pisocarpa* A. Gray

Leaflets obovate, narrowed or cuneate at base, with teeth, directed toward the apex; fructiferous receptacles large or middle-sized; corolla quite large - - - *R. blanda* Ait

11 Paired prickles with tips more or less curved or hooked; upper stipules and bracts narrow; receptacles nearly always smooth *R. Californica* Cham. & Schlecht.

Paired prickles straight; upper stipules and bracts more or less dilated, rarely narrow - - - - - 12

12 Bushes very small, a few inches in height and not surpassing a foot; upper stipules and bracts narrow; corolla very small, not exceeding 20^{mm} in diameter; receptacles often glandular-hispid - - - - *R. spithamæa* Wats.

Bushes not very small; upper stipules and bracts more or less dilated; receptacles rarely glandular-hispid - - 13

13 Paired cauline prickles stout, more or less triangular, with straight tips; upper stipules and bracts much dilated; leaflets often with glandular compound teeth; inflorescences often one-flowered; corolla usually very large; fructiferous receptacles large and with large akenes, rarely glandular-hispid
R. Nutkana Presl

Paired cauline prickles not stout, slender or quite slender; upper stipules and bracts moderately dilated; leaflets usually with simple teeth; inflorescences usually many-flowered; corolla middle-sized or small; fructiferous receptacles small or quite small - - - - - - - - 14

14 Stipules and bracts quite deeply denticulate; foliar teeth directed towards apex; sepals more or less silky outside
R. gratissima Greene

Stipules and bracts entire; foliar teeth quite open; sepals not silky - - - - - - *R. pisocarpa* A. Gray

BRUSSELS, BELGIUM.

THE DEVELOPMENT OF THE CYSTOCARP OF GRIFFITHSIA BORNETIANA.

ARMA ANNA SMITH.

(WITH PLATES I AND II)

THE fruiting portion of *Griffithsia* was described in 1861 by Nägeli,[1] who, however, excluded from the genus several of Agardh's species, among them *G. corallina*, which he included under the genus *Heterosphondylium*. The fruiting branch of this genus he described as consisting of a basal joint, bearing a whorl of enveloping branches, a short terminal cell, and one or two intermediate joints, bearing two, or rarely three, trichophores and the favellæ, besides "a characteristic rounded, flattened cell."

Bornet and Thuret[2] in 1867 confirmed Nägeli's observations in regard to the two trichophores borne by the intermediate cell in this species.

Janczewski[3] in 1877 published a detailed account of the development of the cystocarp in the same species, of which a brief summary is here given. The mother cell of the procarp divides by two horizontal walls into three cells, of which the upper undergoes no further development, while the intermediate cell cuts off an anterior cell, which is functionless, and afterwards produces two lateral cells, each of which divides at once into two cells, one small and appendicular (probably Nägeli's "characteristic" cell). The other, which is larger, divides into a "carpogenic cell," which touches the anterior cell, and a mother

[1] Beiträge zur Morphologie und Systematik der Ceramiaceæ; Sitz. d. königl. bayr. Akad. d. Wiss. **2**: 391–397. 1861.

[2] Recherches sur la fécondation des Floridées; Ann. d. Sci. Nat. Bot. V. **7**: 147. 1867.

[3] Notes sur le développement du cystocarpe dans les Floridées; Mem. de la Soc. nat. d. Sci. nat. de Cherbourg **20**: 109. 1877.

cell of the trichophoric apparatus, which is turned towards the neighboring vegetative cell. The trichophoric apparatus consists of four cells with a trichogyne. After fertilization, all the cells of the procarp gradually die except the carpogenic cell, which increases in size and divides into two cells, of which the upper represents a placenta, giving rise to the lobes of the favella, each consisting of several spores. Only one trichogyne has been found fertilized in a single procarp.

Dr. Farlow,[4] in The Marine Algæ of New England, published in 1882, says of *G. Bornetiana* Farlow: "In the structure of the procarp this species differs considerably from *G. corallina* as described by Janczewski. There is only one trichogyne instead of two, as in the last named species. The procarp begins by the growth of a hemispherical cell at the upper part of an articulation. The cell is then divided into two parts by a partition parallel to the base. It is from the lower cell thus formed that the involucre is formed, and from the upper arise the carpogenic cells in the following way: By usually four oblique partitions there are formed four external hemispherical cells and a central pyramidal cell with a broad base. By subsequent division of one of the hemispherical cells, generally of the one lying nearest the axis of the plant, there is cut off a cell which divides into three smaller granular cells, the upper of which grows into a trichogyne. The spores are formed by the subsequent growth of the other three hemispherical cells."

As a more detailed account of the development of the cystocarp in this species seemed desirable, the present study was undertaken, the special aim being to learn the method by which the spores arise and the means of transmitting the fertilizing influence from the carpogonium to the cell or cells giving rise to the spores. In the course of the study several interesting resemblances between this species and *G. corallina* were observed, which have not been published.

The work was carried on under the supervision of Professor Geo. F. Atkinson, to whose assistance in tracing genetic con-

[4] Report U. S. Commission of Fish and Fisheries for 1879. Washington, 1882.

nections is largely due whatever of value the paper may contain.

The material used in these investigations had been fixed and preserved in a 2 per cent. solution of formalin in sea water. When needed for study, it was stained for an hour in a 1 per cent aqueous solution of acid fuchsin, then washed in fresh water, which was gradually replaced by glycerin, used as the mounting medium. In such preparations it was usually possible to detect the strand of protoplasm passing from a cell to its daughter cell, even though the two were somewhat separated. In some cases, when the connection had been completely broken by accident after mounting, the origin of a cell could be determined by the corresponding portions still projecting from it and from its mother cell. All the important conclusions given in this paper, however, are based upon connections still intact.

The thallus is normally branched dichotomously, and the fruiting branch forms one arm of a dichotomy, arising from the apex of a joint in the upper portion of the shoot. As the corresponding vegetative joint soon exceeds it in size and gives off at its apex, in turn, a fruiting and a vegetative branch, the latter often continuing the process, a series of apparently lateral cystocarps is thus formed. No uniformity in the relative positions of vegetative and fruiting branches was observed, the cystocarp being in some cases on opposite sides of the corresponding vegetative cell in succeeding joints, sometimes on the same side.

After one fruiting branch has arisen, one usually occurs at each succeeding joint, but two or three sterile joints were sometimes found intervening, without branching. No case was observed in which, after the production of a fruiting branch, further branching resulted in only vegetative joints.

Although the normal branching is dichotomous, cases of trichotomy were observed several times, either three sterile joints arising from the apex of one joint, or a fruiting branch accompanied by two sterile branches.

Judging from the preparations studied, the mother cell of the fruiting branch is cut off before the corresponding vegetative

cell, but the latter appears before the first division in the former, a two-celled fruiting branch being accompanied by a corresponding vegetative one. When, in rare cases, an older fruiting branch was found alone and apparently terminal, as in *fig. 3*, it was not always possible to determine whether it was an abnormal state, or whether the sterile cell had been severed by accident.

The mother cell of the fruiting branch is hemispherical, and is richer in protoplasm than the joint from which it arises. It is soon divided by a wall parallel to its base into a flattened, more or less irregular, hemispherical upper cell and a lower irregularly oblong cell.

A cell is now cut off from the upper cell by a wall oblique to the axis of the branch, as is seen in *fig. 3*. When viewed in some positions this wall appears parallel to the first, as is shown in *fig. 4*. Careful focusing in this case, however, showed that the third cell lies partially under its mother cell and is separated from it by an oblique wall. This may be the terminal cell of Nägeli and Janczewski. It lies in this particular case, however, on the side of the branch towards the vegetative cell, while Janczewski, judging from his figures, though he does not explain his view point, terms cells in this position lateral, and these, according to him, arise after the terminal and the anterior cells in *G. corallina*.

Spalding[5] calls attention to the "irregularity in both the number and position of peripheral cells in *G. Bornetiana*." The present study has confirmed his conclusion, and hence has made the use of such terms as lateral and anterior appear of doubtful propriety in this species, at least.

Fig. 5 represents the same stage as *fig. 4*, but with the vegetative cell at one side. Here the first two peripheral cells are plainly "lateral" according to Janczewski's use of the term, but this was not the case in all the preparations studied.

Before the appearance of a third peripheral cell, one of the two first cut off usually divides into two cells, of which the

[5] Development of the sporocarp of Griffithsia Bornetiana. Abstract; Proc. A. A. A. S. 39: 327. 1890.

upper is the smaller (*fig. 6*). A third peripheral cell is now cut off, after which a second peripheral cell frequently divides into two cells, making at this time two two-celled branches and one of one cell arising from the central cell. The term central cell in this paper, as in the one quoted,[6] refers to the second cell of the fruiting branch, from which the peripheral cells are cut off, not to the cell giving rise to the spores, to which the term has been applied by Schmitz[7] and Hauptfleisch,[8] but which is here designated as the placental cell, a name used in this sense by Janczewski. This seems to be the normal order, although cases were frequently observed in which only one of the branches consisted of two cells, while in some cases no "appendicular" cell was found in the entire branch. Dr. Farlow does not refer to this division of part of the peripheral cells, and whether it is not a constant feature in this species, as Janczewski holds it to be in *G. corallina*, or whether the appendicular cell, being specially liable to be severed in manipulation, is thus frequently lost sight of, is not easily determined.

The fourth peripheral cell, to which both Farlow and Janczewski refer, was in no case observed in the earlier stages, and its presence was not demonstrated in later ones. This coincides with Spalding's conclusion in regard to the variability in the number of these cells.

The peripheral cells usually present a flattened hemispherical form in optical section, with beak-like projections of protoplasm where they join the mother cell. When lying over the mother cell, the outline is broadly elliptical. They remain smaller than the central cell, which can readily be distinguished until nearly the last stages of the developmental process by its size and its tetrahedral form, produced by the oblique walls

[6] Farlow, l. c.

[7] Untersuchungen über die Befruchtung der Florideen; Sitzb. d. könig. pr. Akad. d. Wiss., Berlin,—: 215. 1883. English translation of same by W. S. Dallas; Ann. and Mag. Nat. Hist. 13:1. 1884.

[8] Die Fruchtentwickelung der Gattungen Chylocladia, Champia, und Lomentaria; *Flora* 75: 307. 1892.

meeting at the apex. The change in its contents by which it is also made conspicuous in the later stages will be described later.

One of the peripheral cells first produced, which has already cut off an upper sterile cell, now grows rich in protoplasm and becomes the supporting cell of the carpogenic branch, cutting off the basal cell at one side, but apparently not always on the same side, as may be seen by comparing *figs. 8* and *9*. In *fig. 8* two of the peripheral cells have cut off each a sterile cell. The third peripheral cell has been severed from its mother cell, but the point of former contact may still be distinguished on each cell. In *fig. 9* the mother cell of the carpogenic branch has divided into two cells, which are still in very close connection. Here the supporting cell of the carpogenic branch is the only one with an "appendicular" cell, and as neither of the others shows indications that one has been broken off, it is probable that no other has been produced.

In none of the mature carpogenic branches observed were fewer than four cells found. The branch is curved so as to form almost a right angle at the second cell (*figs. 10–13*). The terminal cell, the carpogonium, is smaller than the others, nearly triangular in outline, and prolonged into a trichogyne from the pointed apex.

The trichogyne is an elongated slender structure, as long as the remainder of the fruiting branch, and is straight or only slightly curved, lying in a direction parallel with the axis of the branch. Its diameter is slightly greater at the apex than in the portion adjoining the carpogonium. Its contents do not take the fuchsin stain, but a decidedly granular appearance is observable.

In *fig. 11* a peculiar development is shown, and a somewhat similar, though not quite identical, appearance was observed in another case. The supporting cell of the carpogenic branch has given rise, not to a single sterile cell, but to a branched cellular filament. The carpogonium is slightly larger than usual, and no trace of a trichogyne is seen. It seems probable that in

default of fertilization the disappearance of the trichogyne has been followed by vegetative growth in the carpogenic branch and by the production of extra vegetative cells elsewhere. Here, too, there seem to be four peripheral cells, though the relations of the two cells lying below the central cell were not positively determined.

The process of fertilization and its immediate effects were not observed, lack of suitable material making a nuclear study impossible. In *fig. 12* a pollinoid is shown in contact with a trichogyne, which is enlarged at the point of attachment, but how far fusion takes place was not ascertained.

After fertilization, the trichogyne gradually withers and soon disappears, the basal portion remaining for a time attached to the carpogonium. The latter loses its contents, assumes an irregular form, and becomes disorganized. The adjacent cell at the same time apparently increases in size, but it also soon loses its contents, and in some cases appears to become disorganized, while the two lower cells take a deeper stain than before. Whether the intervening walls are absorbed or a transfer of protoplasm takes place through the enlarged pit connections was not determined, but it is evident that with the disorganization of the upper portion of the carpogenic branch, the supporting cell and the central cell grow rich in contents, the latter especially at this time taking a very deep stain with fuchsin. The carpogonium does not persist long after fertilization, either individually or as a part of a large fusion cell.

Schmitz (l. c.) includes *Griffithsia* among the genera in which conjugation probably takes place between the carpogonium and the supporting cell, which thus becomes the auxiliary cell. He does not state, however, that he has observed the process in any species of the genus. The two cells do not always lie sufficiently near together at the time of fertilization to allow direct conjugation, and no evidence was seen either of change of position or of the growth of ooblastema threads.

In no case was any indication of spore production seen until after a gradual loss of contents in the upper cells of the car-

pogenic branch, which seemed to be followed by changes in the appearance in the lower ones, both following upon fertilization.

At this stage the supporting cell, now rich in protoplasm, increases in size and cuts off a cell, which, in turn, becomes larger, though without taking a deeper stain, and becomes the placental cell. From all sides of this cell, cells arise which are distinguishable at once by their large nuclei, and it is by their subsequent division that the lobes of spores arise, each cell thus cut off from the placental cell developing into one lobe. Each cell cuts off small cells from the sides and end, and soon assumes a cuneate form, the individual segments having a similar or a clavate form. Each lobe consists for a time of a compact mass of cells, but as the cells separate and become rounded off as spores, it develops into a branched tuft made up of loosely connected chains of ovoid or elliptical spores, developed in basipetal succession, each with a large nucleus. The process, however, is apparently not strictly uniform in all cases, as may be seen by comparing *figs. 15–19*. The lobes arise successively, and thus different stages of spore formation may be seen in a single preparation (*figs. 15–19*). According to Harvey[9] each lobe constitutes a favella, and thus several favellæ are contained within a single involucre, while Farlow regards the lobe collectively as constituting one favella.

The favellæ, as well as the vegetative cells of the thallus, are surrounded by gelatinous membrane, which has been omitted in the figures for the sake of clearness. Around the vegetative cells it is so swollen by the glycerin as to be very evident, but it often remains in such close contact with the lobes of spores as to be detected with difficulty.

Directly after fertilization, as the central cell begins to take a deep stain, the growth of the involucral branches begins. The basal cell of the fruiting branch cuts off cells, which remain small and oblong, but from each of which another cell is cut off,

[9] Nereis Boreali-Americana **2**: 227. 1853. Smithsonian Contributions to Knowledge No. 5.

which grows rapidly, assumes at first an obovate, later an elliptical form, slightly reniform, and a length greater than that of the cystocarp. The cells form thin, translucent, expanded plates, and although they completely envelop the favellæ, the cells within may be studied, the details, however, being greatly obscured by them. Seven of these involucral branches were counted in one case, but the number varies. Nägeli and Janczewski call attention to the bicellular character of these branches in *G. corallina*, which, the former states, had been overlooked by systematists, and to which the present writer has found no reference in published descriptions of *G. Bornetiana*.

Although the later stages in the development of the cystocarp are made out with difficulty, the placental cell can be seen to stretch out and become irregular in form, and it seems highly probable, though not quite certain, that fusion takes place between it, the supporting cell, and the central cell, forming one large placenta, the lobes arising from the portion corresponding to the original placental cell. *Fig. 19* is drawn to the same scale as the others, and thus shows not only the great irregularity in the form of this fusion cell, but also the great increase in size over any cell previously met with in the cystocarp. It is difficult to determine the exact nature of the large cells joined to it, but they seem to be sterile cells unconnected with the sporogenous cells, which for some reason have taken on this increase in size.

No evidence was found that the peripheral cells other than the supporting cell of the carpogenic branch have a part in spore production. They gradually become inconspicuous after fertilization, and finally disappear with the carpogenic branch and the sterile cell given off from the supporting cell, unless the branch referred to in the preceding paragraph and represented in *fig. 19* is made up of such cells which have taken on vegetative growth. It is easier to conceive the influence of fertilization as transmitted to the supporting cell through the cells of the carpogenic branch than to the other two or three peripheral cells,

either through the central cell or by separate conjugation with the carpogonium.

The development of the cystocarp in this species thus resembles very closely that of *G. corallina* as described by Janczewski, with the single exception of the one carpogenic branch instead of two. He does not speak, either, of the fusion forming a large central cell, though one of his figures (7) suggests that it may take place.

The process has its more or less perfect analogy in related genera also. In *Ceramium decurrens*, according to Janczewski, the supporting cell, which, after cutting off a sterile cell, gives rise to two trichophores, becomes the "carpogenic cell," cutting off an upper placental cell after fertilization. Schmitz concludes that here conjugation probably takes place between the carpogonium and the supporting cell, but does not claim to have observed it. Janczewski represents the two cells as lying adjacent, and so this fusion would be more easily accomplished than in *Griffithsia Bornetiana*, where they are not always close together, though they are in some cases, as is seen in *fig. 10*.

Phillips[10] states of *Rhodomela subfusca*, *Polysiphonia nigrescens P. fastigiata*, and *P. violacea* that the second cell of a branch cuts off five pericentral cells, one of which, besides serving as supporting cell of the carpogenic branch, gives off two sterile branches, one of two cells and one of one cell, and then becomes the auxiliary cell, cutting off, after fertilization, an upper sporogenous cell. In these cases the carpogenic branch is so curved that the carpogonium lies close to the auxiliary cell, and both Schmitz and Phillips conclude that conjugation takes place between the two, though neither of them actually observed the process. According to Phillips, fusion takes place between the sporogenous cell, the auxiliary cell, and its sterile branches in *P. nigrescens* and *P. fastigiata*, while in *P. violacea*, as apparently in *Griffithsia Bornetiana*, the central cell is included in the fusion.

[10] On the development of the cystocarp in the Rhodomelaceæ, Ann. Bot. **9**: 289. 1895.

In connection with this study the question naturally arises as to the proper limitations in the use of the term "auxiliary cell." Schmitz applies it to cells performing slightly different functions. 1. To a cell of the thallus or of the carpogenic branch which grows rich in protoplasm and then gives up its contents to an ooblastema thread, thus supplying it with the extra nutriment necessary for the production of spores, as in *Naccaria* and *Petrocelis*. 2. To a cell which enters into conjugation with the fertilized carpogonium or with a filament arising from it, and which after thus receiving the influence of fertilization, itself cuts off a cell from which the sporogenous filaments arise, as observed by him in *Glœosiphonia*. It is in this sense that he applies the term to the supporting cell in *Griffithsia*, assuming that conjugation takes place between it and the carpogonium, either directly or by means of a short conjugation process. Mr. Davis,[11] in his description of *Champia parvula*, applies the term to ordinary thallus cells, which, so far as he has observed, do not fuse with any of the cells directly concerned with the development of the cystocarp, but which give rise to the wall of the cystocarp, after a modification of their contents and union with one another and with the supporting cell by means of protoplasmic processes. It seems very doubtful if such a use of the term is in accordance with Schmitz's application of it. It would seem much less questionable to apply it in *Griffithsia* to the supporting cell, which gives rise to the placental cell, even though the influence of fertilization is transmitted through the cells of the carpogenic branch by a broadening of pit connections or the absorption of walls instead of by means of conjugation between the carpogonium and the supporting cell. Janczewski following Bornet and Thuret applies the term carpogenic cell to the cell which gives rise to the spores, whether it be the carpogonium, which these writers regard as a part of the "trichophoric apparatus," or some other cell which performs the function of spore production. Later writers limit the application of carpogenic cell to the cell directly beneath the trichogyne, whatever its fate after fertiliza-

[11] Development of the cystocarp of Champia parvula, BOT. GAZ. 21: 109. 1896.

tion, and there seems to be at present no general term agreed upon for the spore producing cell. The study of the exact process of fertilization and its effects in a greater number of species is necessary before the question of homologies, and hence of terminology, can be definitely settled.

Besides the greater complexity and the presence of the enveloping cells, which render it more difficult to trace the later stages of the development of the cystocarp in *Griffithsia Bornetiana*, the obscurity is increased by the presence in large numbers of dichotomously branched hairs, which sometimes nearly cover the cystocarp. Dr. Farlow calls attention to these hairs arising from the upper border of the thallus cells. In the present study they were never found elsewhere than at the upper portion of a joint, and, with one exception, never on other joints than those bearing cystocarps. In that case it seemed possible that a cystocarp had been broken off, though that could not be demonstrated. Although a cystocarp sometimes occurs without these hairs their presence was found to be so nearly constant as to suggest a possible connection between the two, either morphological or physiological.

CORNELL UNIVERSITY.

EXPLANATION OF PLATES I AND II.

All the figures were drawn with the aid of the camera lucida from material stained with acid fuchsin and mounted in glycerine.

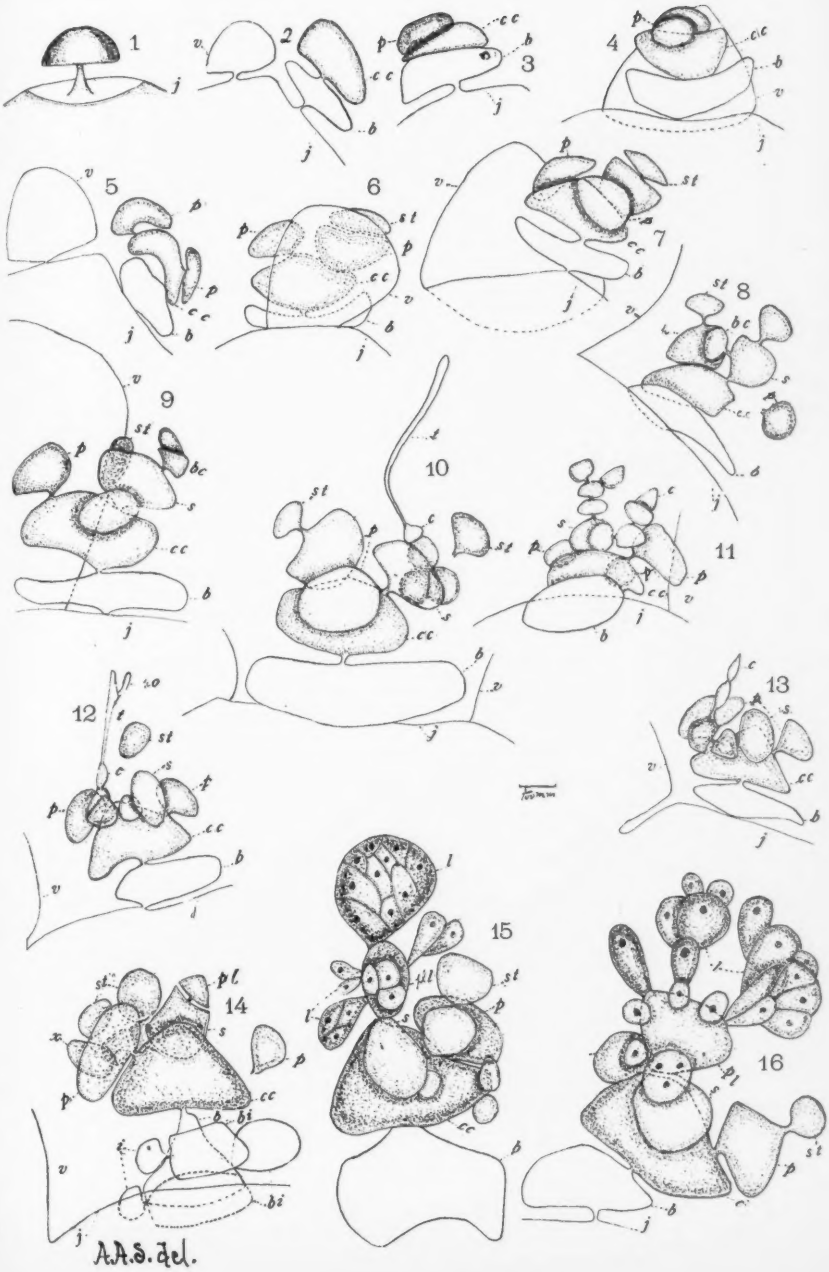
j. Joint from which the fertile branch has arisen. *b.* Basal cell of fruiting branch. *c. c.* Central cell. *p.* Peripheral cell. *st.* Sterile cell cut off from peripheral cell. *s.* Peripheral cell functioning as supporting cell of carpogenic branch. *c.* Carpogonium. *t.* Trichogyne. *pl.* Placental cell. *l.* Sporogenous lobe. *sp.* Spore. *b. i.* Basal cell of involucre filament. *i.* Terminal cell of involucre filament. *v.* Neighboring vegetative cell.

FIG. 1. One-celled fruiting branch, somewhat separated from main joint, but connected by a stout strand of protoplasm.

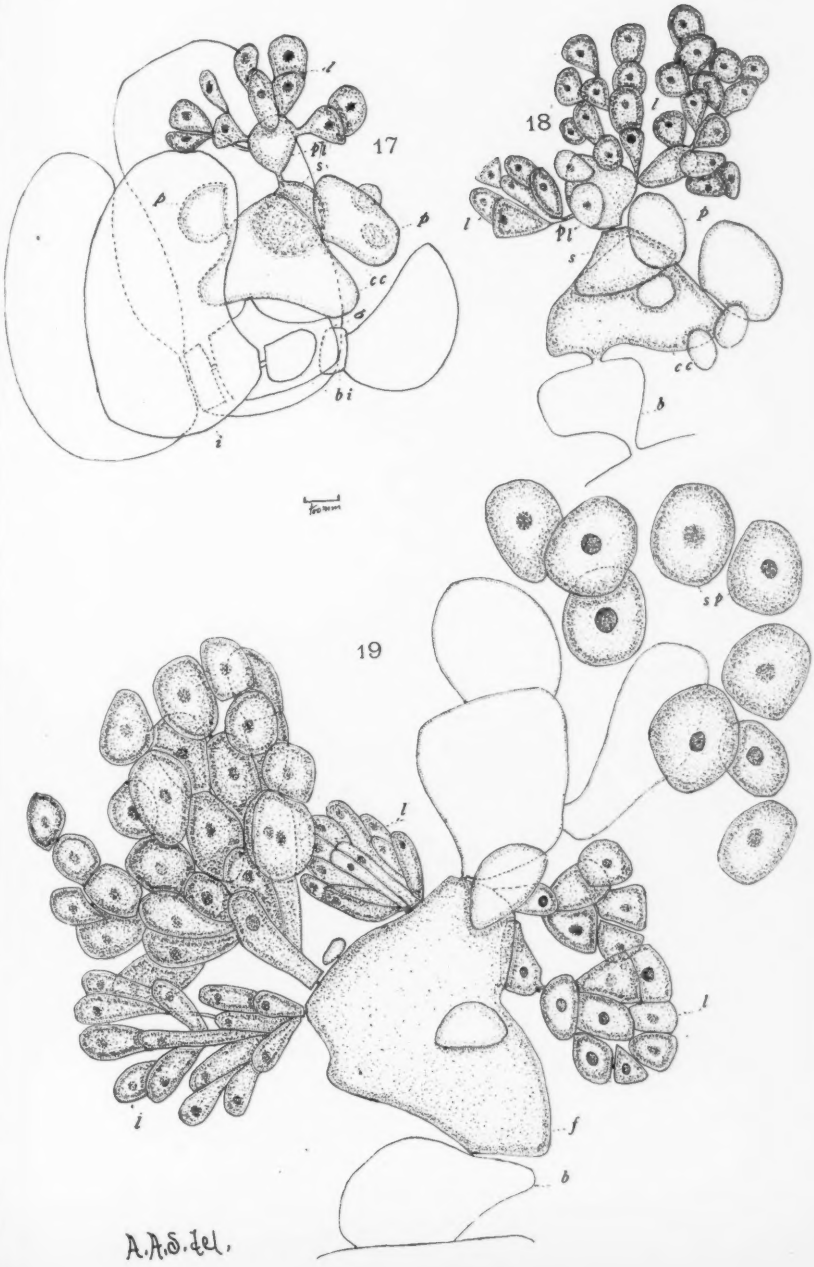
FIG. 2. A two-celled branch.

FIG. 3. The first peripheral cell has been cut off from the central cell by an oblique wall. The vegetative cell has not developed or has been severed.

FIG. 4. The four-celled branch lies over the vegetative cell. One peripheral cell lies partially beneath, the other above the central cell.



SMITH on GRIFFITHSIA.



SMITH on GRIFFITHSIA.

FIG. 5. A different view of a stage similar to that represented in *fig. 4*.

FIG. 6. The branch lies under the vegetative cell. One of the peripheral cells has cut off a sterile cell.

FIG. 7. The third peripheral cell has been cut off from the central cell.

FIG. 8. Two peripheral cells have divided, and the supporting cell has produced the basal cell of the carpogenic branch (*b. c.*). One peripheral cell has been severed from its mother cell.

FIG. 9. The carpogenic branch now consists of two cells. The second peripheral cell has no appendicular cell.

FIG. 10. The entire fruiting branch lies above the corresponding vegetative cell. The carpogenic branch has reached maturity, and the carpogonium is prolonged into the trichogyne.

FIG. 11. An abnormal vegetative development from the supporting cell.

FIG. 12. A pollinoid (*p.*) is attached to the trichogyne. Penultimate cell of the carpogenic branch large and lying partially beneath the second cell.

FIG. 13. The trichogyne has disappeared, and the carpogonium and penultimate cell have lost their contents and shrunken. The second cell of the carpogenic branch, as well as the basal cell, is rich in protoplasm.

FIG. 14. The supporting cell and the central cell have abundant protoplasm. The former has cut off the placental cell. The meaning of *x* is uncertain, its connection with any other cell not being clearly made out. The involucral filaments have begun to develop.

FIG. 15. The entire branch has increased in size. The carpogenic branch has become disorganized, the basal cell remaining attached to the supporting cell. Several lobes are arising from the placental cell, and are seen in different stages. Involucral threads omitted to avoid confusion.

FIG. 16. A similar or slightly later stage than *fig.* 15. Involucral threads again omitted.

FIG. 17. The young cystocarp inclosed in the involucre. Three of the filaments are fully grown; one is still small.

FIG. 18. A slightly later stage with involucre omitted.

FIG. 19. A still later stage. Fusion has apparently taken place between the placental cell, supporting cell, and central cell, and lobes are arising from the large fusion cell (*f.*). Some of the spores are mature, and their connections have been broken. Most of the sterile cells have disappeared, while some seem to have developed abnormally.

NEW MOSSES OF NORTH AMERICA. VI.

F. RENAULD AND J. CARDOT.

(WITH PLATES III—V)

GYMNOSTOMUM CALCAREUM N. et H. var. **Winonense** Holzinger in litt.—Differs from the var. *tenellum* Sch. by the leaves acute and the capsule not constricted at the mouth. Very small and loosely cespitose or gregarious.

Minnesota: Winona, amongst the stems of *Myurella Careyana* (*J. M. Holzinger*, 1893).

Dicranum Demetrii.—In very compact, yellowish-green tufts, brownish and a little tomentose below. Stems erect, simple or sparingly branching, three to four inches long. Leaves crowded, erecto-patent when moist, crispate when dry, from an oblong-obovate base rather suddenly constricted and linear-subulate, canaliculate, smooth, quite entire or subsinuate at apex, 3–6^{mm} long, 0.30–0.60^{mm} broad at base; costa narrow, percurrent or subexcurrent; cells smooth, small, quadrate or short rectangular and incrassate in the upper part, becoming narrowly linear and slightly porose toward the base near the costa, the alar looser, subrectangular. Perichætial leaves from an oblong sheathing base suddenly long cuspidate. Fruit unknown. Seems dicœcious.

Labrador: Rattler's Bight (*Rev. A. C. Waghorne*, 1892; comm. Rev. C. H. Demetrio). Specimens bearing young fructifications and remains of old pedicels.

Seems to have some affinities with *D. elongatum* Schw., but is readily distinguished at first sight from this species by its leaves crisped in dry state, which gives it rather the appearance of *D. montanum* Hedw., and also by the very different areolation of the leaves.

Dicranum trachyphyllum.—Dicœcious. Cespitose, green or olivaceous. Stems erect; 2–6^{cm} long, simple or branching,

sparingly tomentose in the lower part. Leaves falcate or flexuous-patent when moist, flexuous-crisped when dry, often tufted, linear-lanceolate, canaliculate above and rather thickly subulate, strongly serrate on the margins, spinulose-dentate at apex; costa stout, about one-fourth the width of leaf-base, generally very rough at back, percurrent or short-excurrent into a spinulose-dentate point; cells of the upper part quadrate or subrotundate, mostly papillose on the back, oblong or linear and smooth toward the base, the alar lax, inflated, brownish or hyaline. Perichætial leaves from an oblong sheathing base constricted into a long rough subula; costa narrower. Pedicel pale, at last twisted to the left above when dry. Capsule and peristome as in *D. fuscescens*.

Newfoundland: Leading Pickles and Hermitage Bay (*Rev. A. C. Waghorne*, 1893 and 1895).

Closely allied to *D. fuscescens* Turn., to which it might be subordinated as a subspecies, but nevertheless easily distinguished by the leaves more strongly serrate, very rough on the back, less narrowly subulate and the nerve thicker and broader.

DICRANUM FUSCESCENS Turn. var. EATONI Ren. et Card. in *Bull. de l'herb. Boissier* 4:15. (*Musci Am. Sept. Exsicc.* no. 206).—A striking form, approaching var. *flexicaule* BS., but forming dense deep tufts; stems erect, not flexuose, reaching 20^{cm} high; leaves shorter; lower cells less elongated and with thinner walls.

New Hampshire: Mt. Washington (*D. C. Eaton*, 1894). Sterile specimens only.

We received this very interesting variety from the lamented D. C. Eaton some weeks before his death.

Dicranum subfulvum.—Loosely cespitose, dark green, filled with earth below. Stems erect, 1–2^{cm} high, simple or sparingly branched, little radiculose. Leaves erecto-patent, flexuous, crisped when dry, narrowly lanceolate, acuminate-subulate, subula canaliculate, subentire or minutely denticulate at apex; costa strong, very broad, about half width of leaf base, smooth or nearly so at back; cells very small, opaque, quadrate, scarcely papillose, somewhat larger and quadrate or short-rectangular

below, all very chlorophyllose, the alar lax, enlarged, quadrate or subhexagonal, pellucid, yellowish, brownish or subhyaline. Flowers and fruit unknown.

Distinguishable from *D. fulvum* Hook. by the stems not flexuose, the leaves not tufted, nearly entire, the costa broader, smooth or only very slightly papillose on the back and the supra-alar cells chlorophyllose, scarcely distinct from the others.

FISSIDENS DECIPIENS DeNot. var. **Winonensis.**—Differs from the type by its smaller size, the smaller and narrower leaves with the pellucid border most often indistinct and the less opaque areolation.

Minnesota: Winona (*J. M. Holzinger, Mosses of Minnesota*, no. 6).

Trichostomum indigens.—Very small, gregarious, dirty green; stems scarcely 1–2^{mm} high. Leaves patent, subcirrate when dry, 1.25–1.75^{mm} long, oblong-lingulate, obtuse, apiculate or subacute, margins revolute below, plane above, very minutely crenulate by the projection of the papillæ; costa stout, percurrent or vanishing just below the apex; cells minute, rotundate or subquadrate, densely papillose, becoming gradually larger, oblong, rectangular, pellucid and smooth toward the base. Perichætial leaves from an oblong and loosely reticulate base, linear-lingulate, obtuse or mucronate. Pedicel thin, reddish, paler above, 4–6^{mm} long, slightly twisted to the left under the capsule when dry. Capsule small, erect, oblong-cylindrical, chestnut-colored, about 1^{mm} long. Lid unknown. Annulus simple, teeth of the peristome purple, slightly twisting, on a narrow basilar membrane, segments filiform, minutely granulose, marked with a longitudinal line, articulate, slightly nodose and partly connected in the lower part. Probably dicœcious (male flowers unseen).

Newfoundland (*Rev. A. C. Waghorne*, 1895).

Resembling the smallest forms of *Barbula unguiculata* Hedw, by the shape and the areolation of the leaves, but well distinct by the peristome much shorter and less twisted, the teeth describing scarcely half a spiral turn.

ULOTA CRISPULA Brid. var. **dolosa.**—Distinct from the genuine form by the dark green tint, the leaves less crispate and generally broader and the areolation less incrassate, the lower cells looser, shorter, hyaline or greenish, not yellow.

District of Columbia: Tenallytown, mixed with *Orthotrichum Ohioense* and *O. Braunii* (*J. M. Holzinger*, 1892).

This variety differs considerably from the type by its much looser basilar areolation, and would be easily taken for a well distinct species; but we have specimens, gathered at Atco, New Jersey, by Mr. H. A. Green, which are intermediate between this variety and the typical form.

AMBLYODON DEALBATUS Pal. Beauv. var. AMERICANUS Ren. et Card. in *Bull. de l'herb. Boissier* 4: 13. (*Musci Am. Sept. Exsicc.* no. 180).—Differs from the European type by the segments of the endostome more subulate, nodulose and strongly granulose, and by the leaves more distinctly serrate above.

Minnesota: Osceola, St. Croix river (*J. M. Holzinger*, 1890).

PHILONOTIS VENELLA C. Muell. var. **Coloradensis.**—Areolation more chlorophyllose; marginal cells narrower, teeth of the leaves more patulous. Sterile.—Perhaps a small, depauperate form of *Ph. Muehlenbergii* Brid.?

Colorado: Springdale, Boulder co. (*Marie Holzinger*, 1892; comm. J. M. Holzinger).

ANOMOBRYUM FILIFORME Husn. var. **Americanum.**—Differs from the var. *concinnatum* (*Bryum concinnatum* Spr.) by the more slender and shorter stems, the smaller leaves and the shorter cells. Costa percurrent or vanishing just below the point. Sterile.

Wisconsin: Trempealeau Mt. (*J. M. Holzinger*, 1893).

With Rev. Boulay, we consider *Anomobryum filiforme* (Dicks.) Husn., *A. juliforme* Solms, *A. sericeum* De Lacroix and *A. concinnatum* (Spr.) Husn. as belonging to the same specific type, which is widely distributed under numerous local or regional forms, throughout Europe, Africa, North, Central, and South America.

HYPNUM CHRYSOPHYLLUM Brid. var. BREVIFOLIUM Ren. et Card. in *Bull. de l'herb. Boissier* 4: 19 (*Musci Am. Sept. Exsicc.* no. 248). —Leaves shorter and areolation somewhat looser than in the typical form.

District of Columbia: Rock creek (*J. M. Holzinger*, 1891). Sterile specimens.

Hypnum implexum.—Tufts depressed, light green. Stems intricate, pinnately ramulose, branchlets hooked, fastigiate above. Leaves falcate-secund, from a broadly ovate-deltoid base rather suddenly constricted into a narrow subulate acumen, plane on the margins, quite entire or subdenticulate at the base of the acumen; costa double, short; cells narrowly linear, those of the angles few but distinct, small, quadrate, greenish or pellucid. Flowers and fruit unknown.

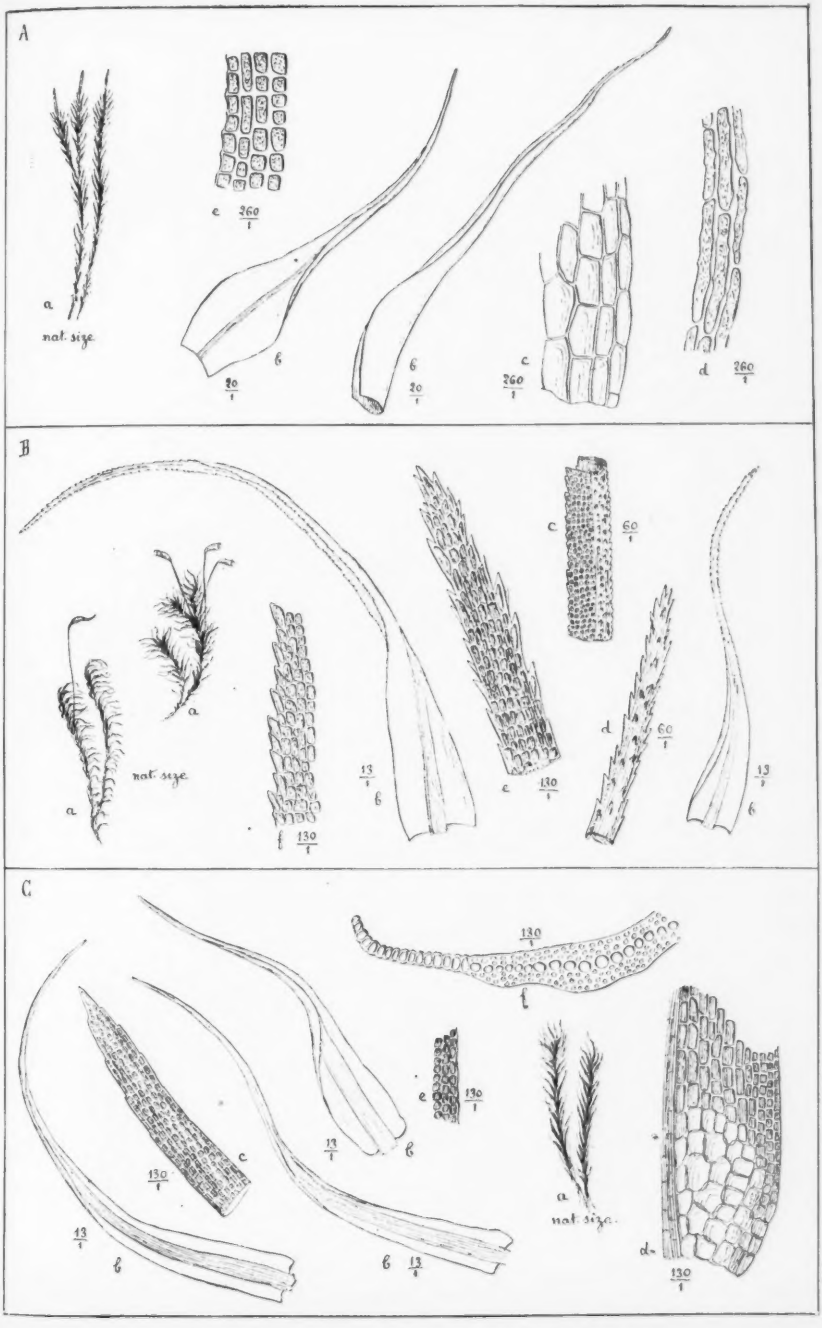
Labrador: Seal Island (*Rev. Arthur C. Waghorne*, 1893).

Allied to *H. hamulosum* Sch., but more robust, and distinct by the light green tint; the leaves broader at base and more suddenly constricted into a subulate acumen, and the alar cells more numerous and more conspicuous. Much resembling the small green form of *H. cupressiforme* L., but in this the leaves are narrower and the alar cells still much more numerous and conspicuous.

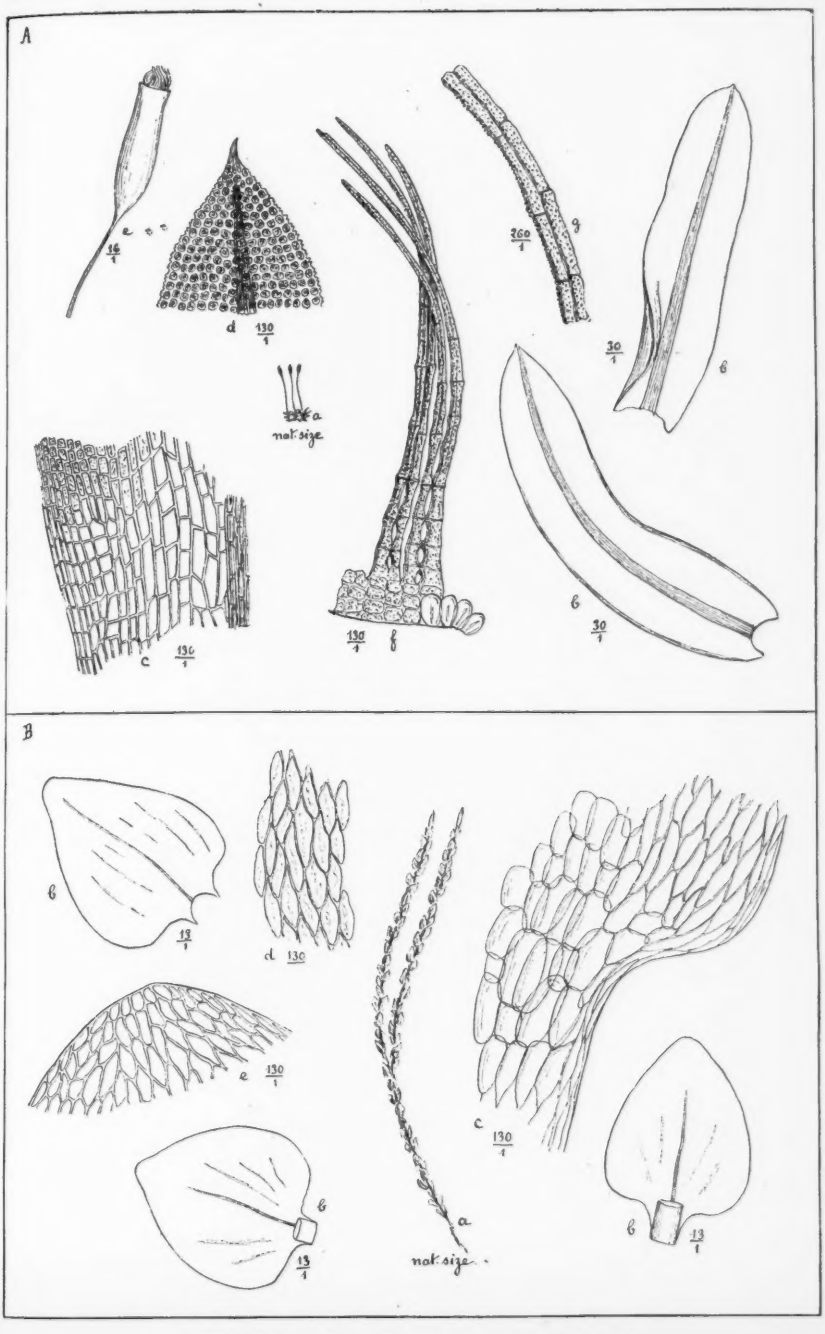
Hypnum subeugyrium.—Monœcious, resembling *H. eugyrium* Sch. var. *Mackayi* Sch., from which it differs by the alar cells of the leaves small, quadrate, not forming excavate auricles and the capsule exannulate. From the forms of *H. palustre* L. having the leaves subimbricate, it is distinguishable by the minutely denticulate apex of the leaves and by the costa always double and shorter.

Newfoundland: Exploits (*Rev. A. C. Waghorne*, 1893).

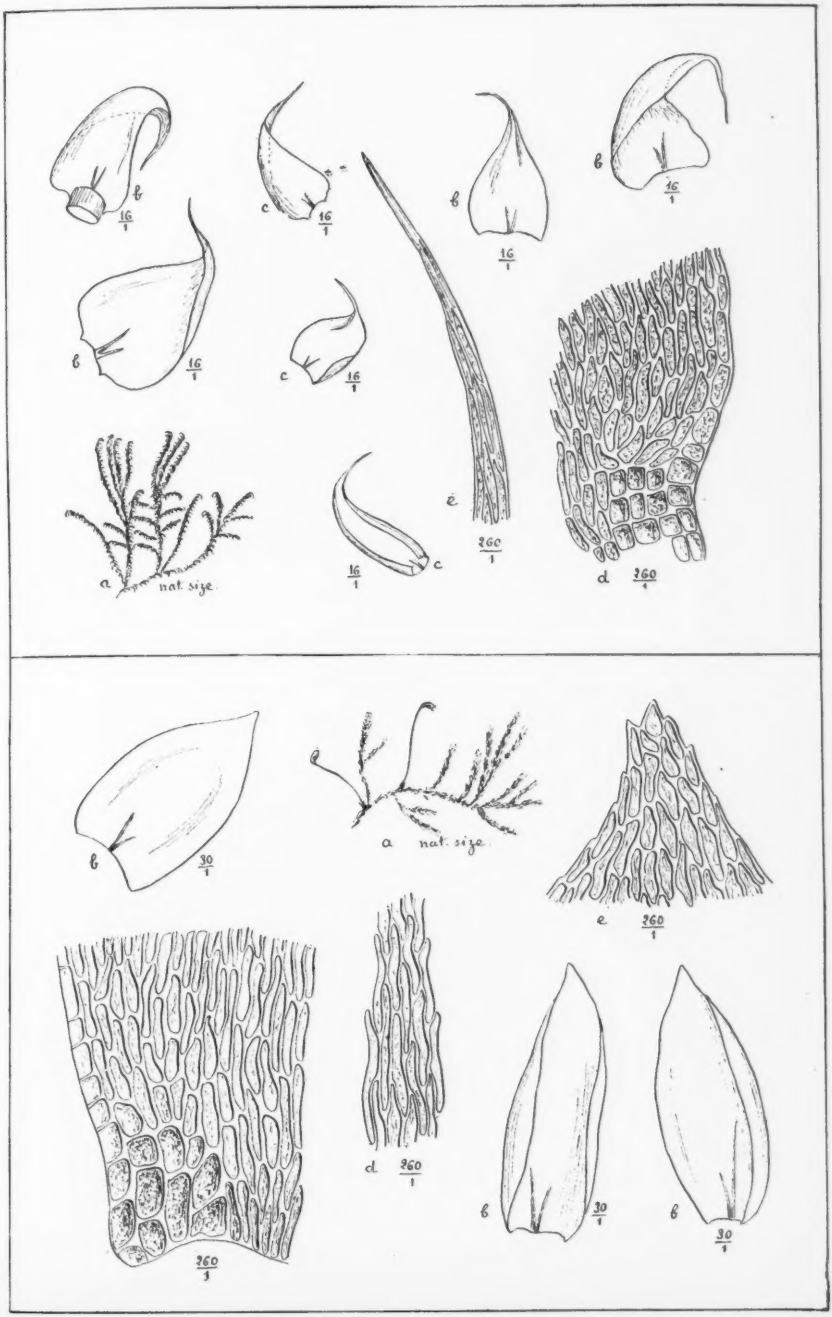
HYPNUM ORBICULARICORDATUM Ren. et. Card. in *Bull. de l'herb. Boissier* 4: 19 (*Musci Am. Sept. Exsicc.* no. 249). Tufts very soft, pale lurid-green above, decolored whitish-yellow and brownish-variegated below. Stems slender, erect, 4–9^{cm} high, simple or sparingly branching, not radiculose, cuspidate at apex. Leaves soft, erecto-patent or very loosely imbricate, subundu-



RENAULD and CARDOT on NEW MOSSES.



RENAULD and CARDOT on NEW MOSSES.



RENAULD and CARDOT on NEW MOSSES.

late when dry, decurrent at base, broadly cordate-suborbicular, very obtuse, quite entire, slightly sulcate; costa thin, vanishing far from the apex; areolation loose, pellucid; cells soft, thin walled, rhomboidal-hexagonal in the middle, the marginal narrower, the upper shorter, the alar very loose, large, soft and empty. Flowers and fruit unknown.

Northwest shore of Hudson's Bay: Depot Island, N. lat. 63° 79′, W. long. 90° 20′ (*George Comer*, 1893; comm. D. C. Eaton).

Easily distinguished from the allied *H. cordifolium* Hedw. by the stems nearly simple, the leaves very soft, broader, and the looser areolation.

VESOUL AND STENAY, FRANCE.

EXPLANATION OF PLATES III–V.

All the figures magnified are drawn by means of Nachet's camera lucida.

PLATE III. A. *Dicranum Demetrii*. *a*, entire plant; *bb*, leaves; *c*, alar cells; *d*, areolation in the middle of the base, near the costa; *e*, areolation of the upper part. B. *Dicranum trachyphyllum*. *aa*, entire plant; *bb*, leaves; *c*, portion of a leaf in the middle; *de*, point of same; *f*, areolation of the borders in the middle. C. *Dicranum subfulvum*. *a*, entire plant; *bbb*, leaves; *c*, point of a leaf; *d*, basal areolation; *e*, areolation of the upper part; *f*, transverse section of a leaf.

PLATE IV. A. *Trichostomum indigens*. *a*, entire plant; *bb*, leaves; *c*, basal areolation of a leaf; *d*, point of a leaf; *e*, capsule; *f*, two teeth of the peristome with a portion of the annulus; *g*, portion of a segment of a peristomial tooth. B. *Hypnum orbicularicordatum*. *a*, entire plant; *bbb*, leaves; *c*, basal areolation of a leaf; *d*, areolation in the middle; *e*, areolation of apex.

PLATE V. A. *Hypnum implexum*. *a*, entire plant; *bbbb*, stem leaves; *ccc*, branch leaves; *d*, angular areolation; *e*, acumen. B. *Hypnum subeugyrium*. *a*, entire plant; *bbb*, leaves; *c*, angular areolation; *d*, areolation in the middle; *e*, areolation of the point.

BRIEFER ARTICLES.

Bark within a tree trunk.—The accompanying photograph is from a section of an elm tree about eighty years old, grown at Oberlin, Ohio. Some forty years ago, by an accident of some kind, the trunk

was split down the entire side and the inner parts rotted away. The split was gradually closed by growth and the two opposite sides folded inwards, each side covered with bark, until the result was reached as seen in the photograph. The two sides produced such a pressure as to obliterate the bark at the line of contact, and a few years more would doubtless have closed the wound with a continuous cambium.

When cut down the bark seemed as vigorous and nearly as thick within the trunk, where it must have been quite dark, as on the outside of the tree.

The section is preserved in Oberlin College museum.—F. D. KELSEY, *Oberlin, Ohio.*

A horizontal microscope (with plate VI).—The laboratory for plant physiology can hardly be considered adequately equipped which does not possess a microscope adapted to measuring directly the vertical growth of plants. The auxanometer, in simple or complex form, is scarcely more indispensable. If no specially constructed instrument is available some makeshift must be devised to enable direct observation of growth. After utilizing common microscopes in various degrees of disorganization, but with unvarying dissatisfaction, the instrument illustrated by *plate VI* was devised by the writer, in consultation with Dr. Rodney H. True, to facilitate whose researches it was immediately needed.

It will be observed at a glance that the general idea of the instrument is that illustrated in Pfeffer's *Physiologie* 2:85, *fig. 8*, which is essentially the form still used in the Leipzig laboratory. Upon comparison, however, it will be readily seen that the instrument here described has a number of points of superiority in the accuracy, readiness, and range of adjustment. It was constructed from my drawings by the Bausch & Lomb Optical Co., of Rochester, N. Y., to whose courtesy I owe the illustration.

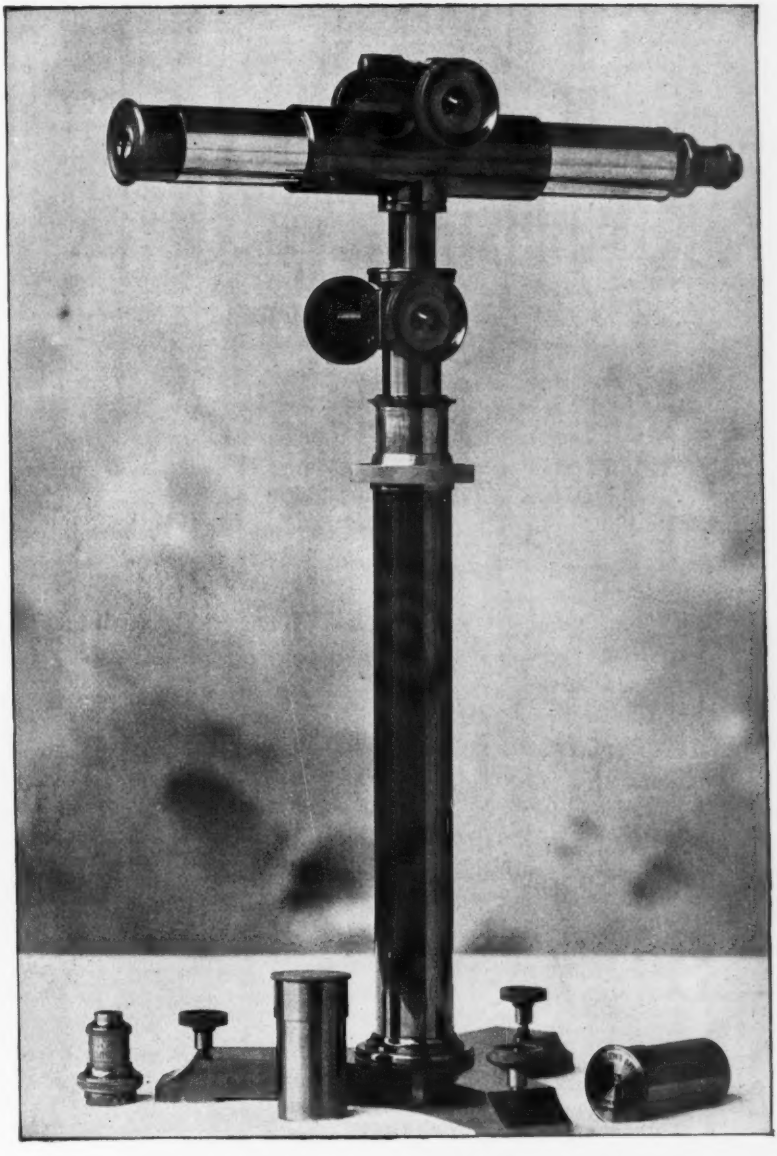
The base is the large lead-filled brass tripod of their "Investigator" stand, with leveling screws. This base is the only part which I now think could be improved. It would be better were it somewhat larger and heavier. Its radial spread is now 10^{cm}; it might well be 12^{cm} with correspondingly increased weight. From the base rises a tube 3^{cm} in external diameter, sawed at the top, where it is pinched by a screw collar. Within the outer tube slides a nickel draw-tube, 22^{cm} long, which can be set at any height, up to its maximum, by means of the screw collar. The upper end of the draw-tube carries a pinion, with double milled heads, engaging a rack on a triangular slide. By means of this rack and pinion the body, which has been roughly brought to the required height by means of the draw-tube, can be accurately set. A finer adjustment has not been found necessary, since a 1^{in} objective has given the highest power required, and with this the micrometer lines can be made to coincide accurately with the tip of the object under observation.

At right angles to the triangular slide is fixed a tube in which moves the nickeled body, actuated by a pinion which engages a rack on the body. This adjustment serves to focus the instrument. Above the pinion, between its milled heads, is fastened a spirit-level, accu-

rately parallel with the body, so that by means of the leveling screws it can be made horizontal.

The optical parts consist of a 2^{in} eyepiece, 1^{in} and 3^{in} objectives. Fixed in the focus of the eye lens of the ocular is a micrometer divided into tenths of a millimeter.

The method of using the instrument is so obvious that it needs no special explanation.—CHARLES R. BARNES, *University of Wisconsin, Madison.*



BARNES on HORIZONTAL MICROSCOPE.

EDITORIAL.

THE ESTABLISHMENT of a biological survey by the Department of Agriculture, under a recent act of Congress, should mark the beginning of a new era in the botanical field-work of the United States. Some work of this kind has been done by the general government, and by different institutions, but it has been desultory and without any general plan. At the head of the new survey no more competent man could have been placed than Dr. Merriam, for his whole work has tended in this direction and his publications have shown a wide grasp of the problems. To be made most effective, large cooperation must be obtained from local organizations, which will work along definite lines in a general plan. The natural allies of the Department will be the Experiment Stations already established in every state, but even these should not be regarded as adequate. Where state biological surveys are organized, these should be associated with the government survey and work under its general direction; and where they are not, such organizations should be formed, or the biologists of the state should individually associate themselves with the general survey. There can be no doubt that abundant and important service can be suggested to every worker by Dr. Merriam. The new survey should prove a great stimulus to the coming generation of botanists, and to the strong movement in botany which is impelling them to emerge from herbaria and laboratories and to come in contact with the larger problems of plant-life. The gradual shifting of the botanical standpoint is becoming daily more evident, and the period of morphology is merging into one to be dominated by physiology, not merely the chemistry and physics of physiology, but the larger field of ecology.

THE MOVEMENT for the appointment of a scientific chief of the department of agriculture seems to have received a check,

whether through its friends or enemies we are not informed. But as it has received already the cordial endorsement of a considerable number of the foremost scientific men and societies, it is be to hoped that it will yet be carried to success. What may be the condition in other lines of scientific work we do not know, but we do know that under the present division of labor in botany there is a dissipation of energy and a duplication of work that might be largely avoided under a more logical and consistent organization, such as could probably be secured by a wise and broad-minded scientific executive. Now that the head of the department holds a cabinet portfolio, it is out of the question to expect other than a political adviser of the President to be appointed. If under him there were a permanent chief, empowered to organize and harmonize all the scientific divisions as the president of a university directs its policy in consultation with heads of departments, we should find increased economy and efficiency of every division. Under the present conditions there is a division of botany, a division of agrostology, a division of forestry, and a division of vegetable physiology and pathology. It is needless to point out the absurdity of the naming of these divisions, which have been split off one by one from the original division of botany. Each now is wholly independent of the others in control, appropriations, quarters and equipment. There is a force of live young men in these divisions and a very great amount of work is done, on whose high quality we have had occasion frequently to comment. There should be a chief of the division of botany, with general direction of all botanical work; the present "division of botany" should be rechristened, while it and the other botanical divisions should be made sections, each in charge of an assistant chief. This would make it possible to concentrate the office and routine work so that each chief would be left freer to push the work of his section. There can be no doubt that under some such plan we should see even more important advances in pure and applied botany than have been possible under the present system.

CURRENT LITERATURE.

BOOK REVIEWS.

Missouri Botanical Garden.[1]

THE ANNUAL REPORTS from this garden have come to be regarded as among the most important contributions to American botany, and the one before us is worthy of its predecessors. The three scientific papers are as follows:

1. *Juglandaceæ of the United States*, by WILLIAM TRELEASE. Since 1893 Dr. Trelease has been preparing a synoptical revision of this group, its publication being delayed from time to time on account of the necessity of additional material. Now that the family has appeared in Sargent's "Silva," Dr. Trelease has thought best not to publish the entire manuscript, and has presented in the paper before us "merely such a tabulation of the fruit, twig, bark and bud characters as it is thought will be helpful in field studies." It is certain that these so-called "winter characters" will be extremely useful, but we wish that Dr. Trelease had given us the benefit of his complete revision. It seems that most of the species are more readily recognized in their winter condition than during the period of flowering or the early summer season. The revision contains our ten hickories and four walnuts, with notes on certain hybrid forms, which are very helpful in explaining certain puzzling forms, which have long troubled botanists. The twenty-five excellent plates, many of them from remarkably clear photographs, thoroughly illustrate habit, bark, buds, etc., and there would seem to be little excuse left for not recognizing our species.

2. *A Study of the Agaves of the United States*, by A. ISABEL MULFORD. The exceptional facilities at the Missouri Botanical Garden for the study of this interesting and difficult genus are well known, and Miss Mulford seems to have availed herself of them fully. The paper is a clear and full presentation of her results, which the thirty-eight plates make still more valuable. A general account of the genus and of its economic uses, which are numerous, prefaces the synoptical presentation of the species. The subgeneric divisions based upon differences in the inflorescence, recognized by Dr. Engelmann, are followed, but Baker's substantive names, *Manfreda*, *Littæa* and *Euagave*, are applied to them. The specific limitations are not distinct, as is to be expected in such a group, and absolute precision in definition is not to be looked for. About twenty species and varieties are presented, three of which are proposed as new.

[1] Missouri Botanical Garden. Seventh annual report. 8vo. pp. 210, pl. 67. St. Louis, Mo. 1896.

3. *The ligulate Wolffias of the United States*, by CHARLES HENRY THOMPSON. Under this title reference is made to the subgenus *Wolffiella*, which the author is inclined to believe is a distinct genus intermediate between *Wolffia* proper and *Lemna*, but unfortunately it has never been known to produce flowers. Only one form has been credited to the United States, and that a variety of the Mexican *W. gladiata*, known only from the subtropical region of Florida. Mr. Thompson found it among the collections of Bush, made in the swampy region of southeastern Missouri, and has also discovered the Mexican *W. lingulata* in California, growing in an irrigation canal near Bakersfield. A careful account of these two forms is given, illustrated by three plates.—J. M. C.

A popular work on ecology.

UNDER the somewhat uncertain name of *The Great World's Farm*, a valuable and delightful work has been written by Selina Gaye.[2] The title was suggested by a passage in Professor Drummond's account of untrodden Africa, and refers to the way in which plants establish themselves and flourish unattended by man.

The subjects treated are the natural methods of soil formation, water and food elements in soil and air, the action of leaves and roots, flowers and their pollination, the distribution of seeds, friends and foes, the chances of life, changes due to man, and similar matters.

This enumeration of subjects does not, however, give any suggestion of the great diversity of topics and the extraordinary array of facts which have been brought together. The work is written from the most modern point of view, and although dealing with scientific matters, technical terms have been so skilfully avoided, that any well informed person may read the book with enjoyment, without possessing previous knowledge of the subject, or of its terminology. The volume also contains much about worms, insects, birds and other animals in connection with the account of vegetation. There are so few lapses from full scientific accuracy that they may be ignored by both reviewer and reader. Some of the historical statements may be taken with a grain of incredulity, such as the story of the Persians keeping pollen of the date for nineteen years during a civil war in order to secure a crop of fruit at its close, yet they are currently accepted and serve to accentuate general truths.

The book is well printed and the illustrations, mostly full page plates, are especially commendable. Altogether the work forms a compact volume of entertaining and instructive information, and can be heartily recommended to the lover of nature whether dilettante or earnest student.—J. C. A.

[2] GAYE, SELINA.—The great world's farm; some account of nature's crops and how they are grown. With a preface by G. S. Boulger. 8vo. pp. x + 365. Illustrated. London: Seeley & Co. 1893. Chicago: The Macmillan Co. $1.50.

The spraying of plants.

NOTHING more remarkable has taken place in the history of botany than the development of methods for the protection of cultivated plants against the attacks of fungi and insects, especially by spraying, and the consequent encouragement given to the study of the life history of fungi. It is scarcely more than a decade since the first impetus was felt, its inception being traceable to the discovery of the value of Bordeaux mixture as a fungicide and Paris green as an insecticide. The former was first used in France and the latter in central United States. The importance of these discoveries cannot be overestimated, and the extent and variety of the practical and scientific results which have followed can only be fully appreciated by one studying the subject. It is therefore a valuable service which Mr. E. G. Lodeman[3] has rendered to practical and scientific men alike by the publication of a work on the general subject of spraying.

In four hundred closely printed pages he has recorded a great number of facts and opinions, and given a clear survey of the growth of the subject and its present status. Beginning with the history and principles of spraying in general, he traces its rise and adoption in foreign countries and in America, together with improvements in machinery for its application; then discusses the action of fungicides and insecticides upon the parasite, the host, and the soil, and devotes the last third of the work to descriptions of fungous diseases and insect enemies of many kinds of plants, with directions for treatment.

There are several aspects in which the work is a specially valuable contribution to scientific literature. The chronological study of the subject in its different lines of development and from various geographical centers, with the abundant reference citations, presents a record of lasting importance, although necessarily limited by the size of the volume.

The fact that America leads in the study of plant diseases, in devising new remedies, perfecting those already known, and in the readiness with which the cultivator accepts and applies the suggestions of the investigator is cause for congratulation, as it augurs well for the continued growth of pathology and incidentally of other branches of botany in this country.

The number of diseases brought to light and the number of remedies suggested have been so perplexingly numerous that the cultivator and the investigator alike will welcome the part of the work dealing with specific diseases and their treatment. Although necessarily brief, it is sufficient for the guidance of the cultivator, and affords the student a needed survey of the field. It is fortunate that insects and fungi are examined with equal

[3] LODEMAN, E. G.—The spraying of plants: a succinct account of the history, principles and practice of the application of liquids and powders to plants for the purpose of destroying insects and fungi. With a preface by B. T. Galloway. 12mo. pp. xvii + 399. Illust. New York and London: The Macmillan Co. 1896. $1.00.

thoroughness in this work, as it gives an opportunity to compare the results of the labors of entomologists and mycologists.

As a piece of book making, the work leaves nothing to be desired. It forms the second volume of the Rural Science Series, edited by Professor L. H. Bailey of Cornell University.—J. C. A.

A new "Vegetation der Erde."

THE CLASSICAL *Vegetation der Erde* of Grisebach will always be looked upon as one of the great books upon the distribution of plants. But recent progress has brought to knowledge much of detail which now needs to be incarnated in general principles. In brief, such is the plan of Professors Engler and Drude. They propose to edit a collection of monographs upon the various phases of plant geography under the general title *Vegetation der Erde*, thinking that the time is ripe for at least beginning a publication which shall, on the one hand, bring to light the lifelong work of some of the older savants, and, on the other, enable younger investigators to know what needs to be done and to plan their studies accordingly.

No definite order for the monographs can be announced, and almost entire freedom will be allowed individual contributors in the arrangement of their material. Naturally the countries of central and western Europe will be the first to be treated, on account of the more thorough study to which they have been already subjected. Each monograph will constitute an independent volume, to be published in the German language, by translation, if need be, from the native tongue of the author. The editors themselves promise some of the general work upon plant geography and plant history, together with the special treatment of certain regions.

This is a courageous plan, demanding even more optimism and energy than the inception of the great *Pflanzenfamilien* which is now nearing completion. We trust that the senior proposer, Professor Engler, of Berlin, will be enabled to see this materialize, as he has seen his monumental *Pflanzenfamilien*. Certainly he will have an able coadjutor in Professor Drude of Dresden. No one who inspects the tentative outline of the work can fail to be impressed with its comprehensiveness. Three sections are suggested The first, treating of climatology in its influence upon the distribution of plants, the developmental history of floras, and phylogenetic investigations upon geologic and biological principles, will naturally be the last to begin. The second will treat the plant formations, especially those of Europe and neighboring regions, while the third will discuss the principles of plant distribution as illustrated by natural floral regions.

An editorial in this journal recently[4] urged students, instead of compiling state floras after the usual pattern, to work out carefully the distribution

[4] BOTANICAL GAZETTE 21: 303. May 1896.

of plants in relation to others and to geographic and climatological features. If any one desires to see what this suggestion means in detail he would do well to examine the first volume of this projected *Vegetation der Erde*, namely, Willkomm's *Grundzüge der Pflanzenverbreitung auf der iberischen Halbinsel*.[5]

The Iberian peninsula is particularly well suited for a special study of this kind, cut off as it is from the rest of Europe by the Pyrenees. While its limit is thereby defined its interior presents exceedingly diversified conditions, the rainfall alone varying from less than 300 mm in small regions about Salamanca and Lérida, to over 1600 mm about Santiago and Roncesvalles, while a large part of the table-land of Old Castile, New Castile, and Aragon receive less than 400 mm. With six mountain systems, in five of which peaks and chains reach the alpine region, and in one the snow-line with peaks of 11,000 feet; with a coast line of 2250 miles, sometimes abrupt, sometimes sand dunes backed by marshes, as diversified a surface as can well be imagined is presented.

After giving an account of the history and literature of botanical exploration in the peninsula and its physical features, Willkomm discusses the peculiarities of the combination of the Iberian flora and its biological statistics; the distribution of the plant formations; the limits of various species whose polar or equatorial limit is therein reached; and the relation of the Spanish-Portuguese flora to that of neighboring countries and islands.

The second part, which constitutes the larger part of the book, depicts the formations and the collective vegetation in each of the five districts into which he divides the region, viz., the Pyrenaic, North Atlantic, central Mediterranean, south Atlantic, and west Atlantic. An appendix treats of the changes in the vegetation through cultivated and adventive plants.

It is impossible for any foreigner to criticise such a work, whose details must be tested by local botanists; but it cannot fail to leave an impression of great thoroughness. To it the venerable author had devoted a good share of his life. It was fortunate indeed for us that he was able to complete the manuscript and to see more than half of it through the press before his death a few months ago. A more auspicious beginning of Engler and Drude's great work could scarcely have been made.

From the publisher's point of view the book is faultless. The two maps, one showing isohyetes and the other the steppes and the vegetation limits, are exquisite specimens of modern cartography.—C. R. B.

MINOR NOTICES.

Dr. T. F. Allen has published another fascicle of his *Characeæ of America*, being part II, fascicle 3. Ten species of *Nitella* are described, and

[5] Willkomm, Moritz. Grundzüge der Pflanzenverbreitung auf der iberischen Halbinsel. 8vo, pp. xvi + 395, *f. 21, pl. 2, maps 2*. Leipzig: Wilhelm Engelmann. 1896. M. 12 unbound; M. 13.50 bound.

illustrated by nine handsome plates. *N. Leibergi* is a new species from Oregon; *N. transilis* is a new species of the north Atlantic states; and *N. Asa-græana* Schaffner, in Herb. Farlow, is Mexican. The other species are *N. mucronata* A. Br., *N. capitellata* A. Br., *N. gracilis* (Smith) Ag., *N. tenuissima* (Desv.) Coss. et Germ., *N. pygmæa* A. Br., *N. minuta* Allen, and *N. intermedia* Nordst.—J. M. C.

THE METROPOLITAN PARK COMMISSION of Massachusetts has issued a catalogue of the flora of the Blue Hills, Middlesex Fells, Stony Brook, and Beaver Brook Reservations, compiled and edited by Mr. Walter Deane. The work could not have been put into more competent hands, as Mr. Deane's acquaintance with the flora of the whole region is most intimate and accurate; and although he insists that the list is but a preliminary one we question whether it is not more complete than most catalogues. The 7508 acres of very diversified territory have furnished a large list of plants, many of which, it is to be hoped, will be carefully guarded. In addition to the vascular plants, the numerous mosses are presented by Edward L. Rand, the Characeæ by J. W. Blankinship, the algæ by F. S. Collins, the lichens by Clara E. Cummings, and the fungi by A. B. Seymour and Flora W. Patterson. The pteridophytes are furnished by G. E. Davenport.—J. M. C.

IN THE SERIES of bulletins issued by the laboratories of Natural History of the State University of Iowa the current number bears the date of February, 1896. Mr. R. I. Cratty makes some useful notes on the aquatic "phenogams" of the state; Mr. Paul Bartsch deals with the Cretaceous flora of western Iowa; Messrs. Ellis and Macbride publish a list of Nicaraguan Hymenomycetes, collected by the university expedition to that country; Mr. B. Shimek notes over fifty species of plants not heretofore recorded as growing in the state, and also new stations for very many of those already recorded, making the very sensible remark, "The object of this list is to add, if possible, to the knowledge of the plants of the state, not to the volume of the nomenclature literature. Therefore, without regard to the present controversy, the nomenclature of the latest edition of Gray's Manual is followed, as the plants will be readily recognized by the names therein given;" and Professor Macbride describes an interesting Nicaraguan puff-ball, *Bovista lateritia* Berk.—J. M. C.

A CONSPICUOUS example of the bookmaker's art is *The White Pine*, by Pinchot and Graves,[6] and this in more senses than one. For the book is scarcely more than a magazine article as to length, by the printer's skill put together most admirably to form a dainty volume. As to contents, its facts and conclusions are confessedly "based . . . on a short period of observation and a comparatively restricted number of measurements." It may be added

[6] PINCHOT, GIFFORD, and GRAVES, HENRY S.—The white pine—a study. With tables of volume and yield. 12mo. pp. xii + 102. New York: The Century Co. 1896.

that these were made in a still more restricted region, viz., the pine forests of Pennsylvania. It is hardly conceivable that tables based on data from 160 trees of which only 100 were over 100 years old, in one of the most unimportant pineries of the country, can be sufficiently well founded to command confidence.

Whatever of good is accomplished by the book will be in showing what forest study aims to do, and how it can be made in this country, as in Europe, of direct commercial value.—C. R. B.

NOTES FOR STUDENTS.

CZAPEK has examined the acid root secretions[7] and found that the commonest source of the acid reaction is primary potassic phosphate, primary potassic oxalate occurring in only a few cases. No free acids, with the exception of carbonic acid, were found.

MM. BERTRAND AND MALÈVRE, whose work upon pectase, a new diastatic enzyme, has already been noticed in this journal, find that it is very widely distributed among plants; so widely that they feel justified in saying that it may be regarded as universally diffused in green plants.[8] It is especially abundant in the leaves and probably spreads to the other organs. It may be prepared from alfalfa or clover by braying in an iron mortar full-grown plants, whose juices are then expressed. This fluid is saturated with chloroform to prevent alteration by micro-organisms and set aside for 12–24 hours in an open flask protected from light. It then undergoes a special coagulation, which renders it easy to filter. To the clear liquid twice its volume of 90 per cent. alcohol is added, which throws down a white precipitate which is collected and dissolved in a little water. After twelve hours it is filtered and the almost colorless liquid which runs through is received in four to five volumes of alcohol. The pectase separates anew and is collected and dried in a vacuum. In this way a liter of juice yields 5–8^{gm} of a white, non-hygroscopic substance, very soluble in water, which produces a vigorous pectic fermentation. A 1 per cent. solution of pectin will be coagulated in forty-eight hours by the addition of $\frac{1}{5000}$ of its weight of the pectase from alfalfa, or $\frac{1}{1000}$ of the pectase from clover.—C. R. B.

MOLISCH describes[9] a new microchemical reaction for chlorophyll, which depends upon a special relation to potassic hydroxide. If a bit of tissue containing chlorophyll, which should not be wet with water, be transferred to a *saturated* watery solution of KOH, the chlorophyll bodies become almost instantly yellow-brown, changing again in 15–30 minutes almost to green. The

[7] Berichte d. deutsch. bot. Gesells. **14**: 29. 1896.

[8] Jour. de Bot. —: —. 1896.

[9] Ibid. p. 16.

change of the yellow-brown (which the author compares to the color of living diatoms) to green follows immediately upon heating to the boiling point or by the addition of water, and somewhat less quickly upon the addition of alcohol, ether, or glycerin.

Chlorophyll bodies killed by boiling water, by drying, or by any medium which does not destroy the coloring matter, show this reaction likewise. Solid chlorophyll prepared from an alcoholic extract also shows it. Alkali-chlorophyll does not; which confirms the contention of Tschirch, Schunck, and Marchlewski, as against A. Hansen, that dilute alkalies do alter chlorophyll.

Diatoms and brown algæ, after being killed by boiling water, upon which they become green, show the reaction, but in Florideæ and Cyanophyceæ its value is impaired by the accompanying reactions of phycoerythrin and phycocyanin.

No other bodies have been found by Molisch to respond to the chlorophyll test.—C. R. B.

MOLISCH also gives an account[10] of the crystallization of xanthophyll and his method of recognizing this yellow coloring matter which always accompanies chlorophyll. Inasmuch as the two are separable in solution, it seemed possible to devise a mode of removing the chlorophyll and leaving the xanthophyll *in the leaf*. The process is as follows: Fresh green leaves or small pieces of them are brought into 40 per cent. (by volume) alcohol which contains 20 per cent (by weight) of KOH. In this they remain several days protected from light, until all the chlorophyll is extracted. To prevent absorption of CO_2 this should be done in glass preparation jars with close-fitting glass stoppers. The potash solution is then washed out for several hours with distilled water and permanent preparations made by mounting bits of the leaves in pure glycerin. The xanthophyll is found crystallized in almost every previously chlorophyllous cell.

This process has yielded the described result in about 100 genera of seed plants at different times of year. Only rarely does the xanthophyll remain as yellow drops or diffused in the cell sap.

After giving an account of the physical and chemical peculiarities of the crystals Molisch points out the close similarity of the yellow coloring matters, xanthophyll, chrysophyll, etiolin, phycoxanthin, etc., and their relation to carotin. He proposes the use of the word carotin in the broad sense, already given to it by Zimmerman,[11] to designate all the yellow and orange-red crystals of the leaf obtained by the method described. It would therefore designate not a chemical individual but a group of nearly allied substances, just as "sugar" and "albumen" do.—C. R. B.

[10] Berichte d. deutsch. bot. Gesells. 14:18. 1896.

[11] Bot. Mikrotechnik 99.

In a second contribution on "The influence of light upon the form of Cacti and other plants,"[12] Goebel discusses the dependence of the form of the leaves of *Campanula rotundifolia* upon the intensity of light and introduces some remarks upon the dependence of the heterophylly of a few other plants upon external factors.

The usual form of *Campanula rotundifolia* is well known in the northern states. The early round leaves, from which it takes its specific name, form a radical rosette, but often perish early, so that the name seems very inappropriate when only the linear-lanceolate upper leaves are seen. The erect flowering branches arise in the axils of the lower leaves of the rosette and normally produce elongated leaves. Goebel was able, by diminishing the light, to cause shoots to produce round leaves exclusively until more strongly illuminated, when they formed long leaves. Others in weak light produced shoots in the upper axils bearing round leaves. But the most instructive case was that in which a shoot, after producing normal leaves, gradually returned to the development of round leaves, those at the tip of a 20^{cm} shoot being of typical orbicular-cordate outline. To determine whether the formation of the round[13] leaves could be suppressed by strong illumination from the beginning, or whether the process of development is so ordered that under all conditions round leaves appear first, plants were subjected to artificial illumination, finally with two arc lamps of 2000 c. p. each. But in no case was the formation of round leaves hindered. Goebel argues, therefore, that *Campanula rotundifolia* has not inherited the *Anlage* of two (or if one considers intermediate forms, many) leaf forms whose appearing is determined by the different degrees of intensity of light as a releasing factor, but only the *Anlage* of the round form, which under the normal condition of sufficient light is transformed into the long type, not suddenly but gradually, so that various intermediate forms appear. In the course of the ontogeny of an individual leaf these intermediate forms do not appear because the transforming factor very early directs the development of the leaf *Anlage* into another course. But if this factor be removed the inherited form reappears, as in the cultures in weak light.—C. R. B.

Dr. J. Wiesner, who has contributed so much to the general subject of physiology, gathers up[14] in a rapid review the suggestions he has made in regard to the phenomena and terminology of the inequilateral growth of plant members. Having summarized the various forms of heterotrophy of tissues and members—evidently in many cases a complex phenomenon, which is conditioned on the one hand upon innate peculiarities and on the other upon

[12] Flora **82**: 1–13. 1896.

[13] Goebel says, apparently by a slip of the pen, "Langblattform," instead of "Rundblattform."

[14] Berichte der deutschen botanischen Gesellschaft **13**: 481–495. 1896.

external influences — he proposes to cover all cases by the simple special term *trophy*, which he defines as follows: "By *trophies* I understand all one-sided accelerations of growth in tissues or organs which depend upon the position of the organs concerned; position being taken in its widest sense as indicating the spatial relation of the heterotrophic organ to the horizontal . . . . and to its mother shoot."[15]

As to position with reference to the horizontal, there are to be distinguished epitrophy and hypotrophy; as to position with reference to the mother axis, exotrophy and endotrophy. The two latter are fixed by heredity. Influences effective by reason of position with reference to the horizontal, such as light, gravitation, and unequal wetting by precipitation, lead to paratonic trophies, which may be more exactly designated as phototrophy, geotrophy and hydrotrophy.

Wiesner then sums up the final results of his researches on anisophylly, which he holds to be evidently the result of combined trophies, in these words:

"1. Anisophylly, *i. e.*, the inequality of the leaves of the shoot in consequence of position (in the above exactly defined sense) serves, as a rule, to make possible to those plants with more abundant foliage a suitable fixed light position of the leaves themselves without the twisting of the internodes.

"2. For attaining this object plants utilize various trophies, either spontaneous (commonly exotrophy), or paratonic (phototrophy, hydrotrophy, probably also geotrophy), or both, which is the common method."—C. R. B.

IGNAZ FAMILLER has a paper in the current number of *Flora* (April) entitled "Biogenetic researches upon reduced or metamorphosed sexual organs." A brief extract of some of the important points will be useful, but the full paper should be read to appreciate the investigations upon which the conclusions are based. Cases in which plant organs have been reduced or transformed to meet changed conditions are by no means rare, and in the floral parts these phenomena are quite extensive. The author disregards all isolated observations of reduction and transformation, because only chance observations are accessible; and also excludes all diclinous plants, as they would need an entire paper for adequate consideration. His application of sexual terms to stamens and carpels is certainly reprehensible, but using his own phraseology, the main points are as follows:

Male Organs.— Viewed from the standpoint of the typical structure of the normal anther, the rudimentary organ remains permanently in some stage of development through which the normal organ passes. The degree of devel-

[15] "Ich verstehe unter Trophieen alle an Geweben oder Organen vorkommenden einseitigen Wachsthumsförderungen, welche von der Lage des betreffenden Organs abhängen, wobei aber Lage in weiterem Sinne genommen wird, nämlich als die räumliche Beziehung des heterotrophen Organs zum Horizont . . . . und als die räumliche Beziehung des heterotrophen Organs zu seinem Muttersprosse."

opment may vary considerably, sometimes the reduced organs being almost imperceptible and sometimes almost normally developed. Goebel remarks "That 'normally' reduced organs occasionally develop is common enough." The ray flowers of Compositæ, the fifth stamen of *Acanthus mollis* and the outer flower of *Viburnum Opulus* show the stamen in the form of a roundish elevation hardly perceptible to the naked eye. In a further step this first development is visible but no archesporium is formed. In many cases the rudiments are raised upon filaments as in *Catalpa*, or the entire organ may have a leaf-like aspect as in staminodia of *Linum*.

Another step shows that a cell-division which would otherwise lead to normal anther development sets in, but the staminodium remains in an interrupted stage. Here great variations are possible. Only the archesporium mother-cell may differentiate. Usually, however, more divisions occur and one can find the development arrested at all stages. In *Boronia* the staminodia in outward form closely resemble stamens. In *Boronia megastigma*, in earlier stages of development, stamens and staminodia show the same cell divisions, but in the staminodia the archesporium is smaller and so changes itself by repeated division that in the mature staminodium the cell divisions bear no resemblance to those of stamens. A nearly normal development is seen when the anthers form regularly but remain smaller than the perfect anthers, as in *Cassia*. When staminodia are to serve as organs of secretion, cell divisions resembling archesporium formation set in, but the epidermal cells frequently take part and so furnish an outlet for the secretion. The case in which staminodia become petaloid with no trace of anther formation must be considered the most extreme transformation.

As to the function of staminodia, two observers disagree. H. Müller[16] and Heinricher[17] regard them as useless organs, while Kerner v. Merilaun doubts whether any plant produces anything which is not of advantage and which is not necessary. Even those organs which people so freely call "rudimentary" are not without meaning for the life of the plant. Our author believes that the transformed stamens play a useful rôle in the economy of the plant. They may serve for attraction, they may be a protection to the young stigma, they may furnish a resting place for the insect visitor, they may secrete honey, they may direct the insect to the honey or prevent the honey from running out.

In flowers with many stamens and staminodia the transition from one to the other is gradual. A reduction of the anther-cells in size and number, a one-sided development of the same, a crowding from the normal position and also changes in the vascular bundle, filament and connective are shown by transitional forms.

[16] Schenk, Handbuch der Bot. **1.**

[17] Oesterreich. Bot. Zeitschrift **44**:—. 1894. [no. 2.]

Various examples from *Acanthaceæ*, *Bignoniaceæ*, *Commelinaceæ*, *Gesneriaceæ*, *Labiatæ* and *Scrophulariaceæ* are considered in detail.

Gynæcium.—Reductions in the gynæcium are not uncommon. Sometimes there is only a slight trace of it, or the carpels may appear as little elevations, the ovary may form and show the beginning of a placenta, the ovule may appear but with the embryo-sac-mother-cell and the integument formation checked, or the embryo-sac may form but with the integuments suppressed, or, finally, the ovule may form normally and may seem capable of fertilization, but on account of position or general weakness of development may become stunted.

Several members of the *Caprifoliaceæ*, *Valerianaceæ* and *Umbelliferæ* are considered in detail. *Quercus* and *Tilia* proved very difficult, and decisive results were not obtained.

Entire Flowers.—The most easily explained case of reduction of the entire flower is that in which the upper flowers of a rich inflorescence fail to develop because the nutritive materials are taken by the earlier, lower flowers.

Flowers may become sterile on account of abnormal enlargement of the floral axis as in the garden form of *Celosia cristata*, or through the enlargement of the floral envelopes as in *Viburnum* and *Hydrangea*. This completes the transformations which are caused by an effort on the part of the flower to serve other than reproductive purposes, like the attractive apparatus of the transformed flowers of *Muscari comosum*, the reduced flowers of *Rhus Cotinus*, whose pedicels serve as wings for the seed, or, finally, the transformation for glands in *Sesamum*.

Arum maculatum, *Brassica oleracea*, *Celosia cristata*, *Hydrangea serrata*, *Muscari comosum*, *Oncidium heteranthum*, *Rhus Cotinus*, *Sesamum orientale*, and *Viburnum Opulus* were the forms studied.

The author's résumé of his entire work is about as follows:

1. The reduction or transformation of arrested organs is a standstill (stehen bleibe) at different stages of normal development.

2. In arrested male organs the commonest cases are the following: (*a*) A standstill at a primitive stage with a feeble development of a perianth, or (*b*) a part of the cell-divisions appears which in the normal organ leads to the formation of the anther wall, but the usual archesporium does not proceed further or divide.

In female organs, generally, but not always, the embryo-sac is formed but integument formation is reduced. If the reduced ovules develop like the normal in their entire structure, they are at least smaller.

3. In flowers with many stamens and staminodia the transition from one to the other is gradual.

4. If the reduced male organs form pollen, the pollen grains, though fewer in number, are still like those of the entirely normal organ, an observation which agrees with the results of E. Amelung in his work "Ueber mittlere

Zellengrössen," where he says different sized organs of the same sort in a plant individual consist of cells of the same or nearly the same size (*Flora* —: 207. 1893).

5. Filamentous staminodia as they appear, *e.g.*, in species of *Pentstemon* correspond not to the filament alone, but they show in young stages a remnant of anther formation in their cell structure even if this is not outwardly apparent.

6. The transformed male organs, like normally transformed and sterile entire flowers, serve for the enlargement of the attractive apparatus, for mechanical devices for the direction of insects or for secretion.

7. There is a genuine transformation of the organ. Staminodia begin like normal stamens and partly complete the further development, but toward the end they form organs of secretion.

Finally, it must be noted that mechanical causes cannot explain the reduction or transformation of these organs, because often from the first, without an external cause, a different formation is recognizable. It may be necessary to take into consideration an inner power resting in the plasma, so that sometimes, as Eichler remarks, the later development of the flower even at its earliest inception may exercise a noteworthy influence, and sometimes, by the entrance of internal disturbances, changes in the typical, external form may take place without necessitating the question of atavism.—CHAS. CHAMBERLAIN.

OPEN LETTERS.

To the Editors of the Botanical Gazette:—Will you kindly allow the following few words of explanation in reference to certain statements made in a book review in the April number of your magazine? The writer first begs leave to thank the reviewer for the occasion thus given to make at the same time an explanation, or perhaps an extension, of the preface of the little book on plant anatomy. It is quite evident that it was the first effort or its kind ever undertaken by the author, and it is a somewhat consoling reflection that probably had a clearer and more definite statement been made of the purpose for which the book was written, it would have prevented, in some degree at least, certain unfavorable criticisms.

It was taken for granted that the title, *Elements of Plant Anatomy*, would of itself suggest the fact that the plan pursued by the author in teaching these "dry bones" of the science was an exact parallel to the modern one adopted by biological teachers in the different departments of descriptive work, or that known as the type system. According to this, a bird's-eye view of the field is first taken and a foundation laid upon which the superstructure is to be raised, either by lectures or text books of an advanced character or both. But nowhere in the book is it stated that it was designed *not* for teachers but for students, and to be used by them as a framework merely, upon which each individual teacher could build by filling out the outlines in his own way. It is in no way fitted for a reference book except for the learner.

It was therefore by design and not through accident or ignorance that the recent theories, such as those relating to nuclear division and the nature of the starch grain, were omitted and the simple elementary facts upon which the later investigations are based were alone considered. That a serious and disappointing error has been made in the determination of what is really elementary in character is certainly a matter to be regretted. At the same time, as the reviewer kindly suggests, it is a mistake which may easily be corrected in a future edition.

It is, however, quite otherwise with certain statements made in the review which must have resulted from a hasty or careless perusal of the text and it is to these especially that the author begs to call attention. That a misstatement or a misrepresentation of the facts of the development of the tissues of plants has been made, is a charge so serious that simple justice must allow the author a chance to plead not guilty.

In answer to several of these charges, it is only necessary to refer to numerous German, French and English text-books whose authority rests upon

original monographs. For example, the definition of bark, which is criticised, differs in no essential point from that given by De Bary in his text-book on anatomy and repeated by Vines in his text-book of botany, published in 1895. In fact, the same definition was given in an article on "Cork Wings," which was printed in the BOTANICAL GAZETTE in 1888. The expression objected to in regard to the formation of the cambium ring is a very common one in numerous German books, and its truthfulness has never before been called in question, at least to the author's knowledge. This is also true of the statement made concerning monocotyledonous stems, namely, that they may change from the mono- to the dicotyledonous type. It is not quite so evident perhaps that the tracheids and accompanying cells may be called the assistants of the ducts and sieve-tubes. Even here the author can lay no claim to originality. Almost all modern text-books of plant physiology contain a similar statement or intimate that such is the fact. The phloem carries the prepared food about the plant, the sieve-tubes the insoluble, the accompanying cells the soluble portions; while whatever may be the function of the ducts it is admitted by all authoritative writers that the tracheids aid them in this function, or, in certain cases, supply the place of the ducts which are wanting. With reference to the "confusion regarding the elements of secondary bast," etc., it is, perhaps, only necessary to say that the statements made on this subject were the result of the comparative study of all the leading text-books as well as numerous original articles, and, we may add, a modest amount of original work on the part of the author. The language was made as simple as possible, and it may be that the entire omission of the customary technical phraseology caused the reviewer to suppose something must be wanting.

For one familiar with the facts of plant anatomy by years of study, not only of text-books but also of the plants themselves, it is hard to conceive how a candid critic could take exception to these statements. Indeed, if the author may not be considered "authority" on these subjects she has erred in company with the illustrious scientists of the present and past, with such men as Naegeli, Cramer, De Bary, Sanio, Vines, Reinke and Schwendener.

The author heartily agrees with the reviewer in wishing the book were better and also in the hope that a revision, in the near future, may be made which will render it more useful. EMILY L. GREGORY, *New York City.*

[The reviewer must call attention to the fact that as regards the "bark" he merely raised the question whether it was the *Borke* of the Germans which is "commonly called bark." He is aware that in English translations of German works this word has been translated *bark*, but he is unwilling to accept "authority" on this question, with which he may deal elsewhere shortly.

As to the cambium ring: since the completion of the ring by the formation of interfascicular cambium *precedes* the formation of secondary bundles, the reviewer cannot understand how the ring "may be said to be formed *either*

by the intercalation of new bundles *or* by the formation of interfascicular cambium." And that "numerous German books" say it in no wise enlightens the obtuse critic.

Dr. Gregory misses the point of the criticism regarding the so-called change in structure of a stem as it grows older from the mono- to the dicotyledonous type. The fact was not questioned. But does it not strike her as a poor sort of classification (albeit widely used) which makes no better provision for such a fact? Is it possible to maintain as types of structure those which are subject to so many exceptions as these?

The statement that "there is certainly confusion regarding the secondary bast fibers and the similar tissues arising from the pericycle" is based not upon simplicity of language but upon the author's inclusion of all thick-walled fibers and stone cells in the "elements of the secondary phloem" (p. 129). If they are not included by her in that category, then there is the entire omission of any statement that such tissues often belong to the pericycle instead of to the secondary phloem; in which case the confusion would be transferred from the author to the students using the book.—ED.]

NEWS.

DR. WILLIAM TRELEASE is now in Europe. He will return about August first.

HARVARD UNIVERSITY at its recent commencement conferred upon Professor W. G. Farlow the degree LL.D., an honor most worthily bestowed.

THE LAST ISSUES of Lloyd's *Photogravures of American Fungi* (nos. 9 and 10) illustrate *Polyporus Berkeleyi*, and maintain the high character of the previous issues.

PROFESSOR D. T. MACDOUGAL has an untechnical article on the colors of plants, especially the non-green colors, in the May number of the *Popular Science Monthly*.

PROFESSOR THOS. A. WILLIAMS, professor of botany in the Agricultural College of South Dakota, has been appointed an assistant in the Division of Agrostology in the Department of Agriculture.

DR. J. W. HARSHBERGER, in pursuing his ethno-botanical studies, has reached the conclusion that the pumpkin is indigenous in America, a view which he elaborates to some extent in *Science* (June 19th).

MR. A. A. HELLER has been appointed instructor in botany and curator of the herbarium in the University of Minnesota *vice* E. P. Sheldon, who resigns to find a more congenial field in the real-estate business.

MR. JAMES BRITTEN has published an account (*Jour. Bot.*, June) of Arruda's Brazilian plants, the occasion of it being the doubtful or inaccurate citation of them in what he is pleased to call "Jackson's *Index*."

A NEW CASE of apparent symbiosis, between *Tetraplodon* and *Peziza*, n which the rhizoids of the moss were associated with the fungus hyphæ, has been found by Professor F. E. Weiss. (*Rep. Brit. Ass.* 1895: 855).

IN THE *Bull. Torr. Bot. Club* (May), W. W. Rowlee and K. M. Wiegand describe some very interesting hybrids of *Salix candida*, found near Ithaca, N. Y.; and S. M. Tracy and F. S. Earle describe numerous new fungi from Mississispi.

A LIST OF forty-seven freshwater algæ new to Great Britain is given by W. and G. S. West in *Jour. Roy. Mic. Soc.*, April, 1896. Fourteen new species are described with two new genera. Two plates of very crowded illustrations accompany the list.—S.

DR. V. F. BROTHERUS, of Helsingfors, left about the middle of April upon a botanical journey into central Asia. He will explore the high mountain flora of Issikul, giving particular attention to the mosses. He expects to return about the first of September.

PROFESSOR C. S. SARGENT, of Boston, and M. H. de Vilmorin, of Paris, are the best known of the four recipients of the Veitch medals, awarded by the Royal Horticultural Society to gardeners promoting the advance of horticulture. (*Gard. Chron.*, May 16).—S.

PROFESSOR GANONG, of Smith College, has distributed, as a separate from the elective pamphlet, an outline of the courses in botany offered for 1896–7. It would be useful to botanists if the practice were general, so that each might know what is offered to students in the way of advanced work.

A WELL-EXECUTED colored plate of *Erythronium mesochoreum* Knerr is published in the commencement number of *The Midland*, the college magazine of Midland College, Atchison, Kansas. A short general account of the plant by Professor E. B. Knerr is also illustrated by text figures of sterile and fertile plants of *E. albidum* and *E. mesochoreum*.

A CONTINUATION of Briquet's *Labiatæ* forms part 134 of *Die Natürlichen Pflanzenfamilien*. We note in it the splitting up of *Cedronella*, retaining the old name for the single species of the Canary islands, and recognizing two American genera, *Meehania* Britton, and *Brittonastrum* Briquet. Part 135 contains the conclusion of Engler's *Burseraceæ*, and *Meliaceæ* by H. Harms.

MR. F. S. EARLE, formerly connected with the Gulf Station of the Mississippi Agricultural Experiment Station and with the Agricultural Department of the United States, was appointed adjunct professor of horticulture at the Alabama Polytechnic Institute in January last. Upon Professor Underwood's appointment to Columbia University he was recently promoted to the professorship of biology.

FOLLOWING the appearance of our violets in the *Synoptical Flora*, Professor E. L. Greene (*Pittonia*, May 16), and Mr. C. L. Pollard (*Proc. Biol. Soc.*, Wash., May 26) have added to the literature of the genus. The work of the former was mentioned in this journal for June. Mr. Pollard deals with the purple-flowered acaulescent forms of the Atlantic coast, presenting ten forms, of widely different limitation and nomenclature from the presentation of the same forms in the *Synoptical Flora*.

RECENT NUMBERS of the *Gardeners' Chronicle* (Apr. 4, 18, and May 2) give considerable space to a discussion of the larch disease, or blister, caused by the fungus, *Peziza Willkommi*, with several illustrations. The disease originates probably in early spring when the hydrostatic pressure is consider-

able. Though essentially a bark disease, it frequently causes malformations of the trunk and even the death of the tree. Cold and damp are thought to be the prime causes. — S.

IN A PAPER read before the London Pathological Society, Mr. S. G. Shattuck gives the results of some investigations in regard to the healing of incisions in vegetable tissues. When both surfaces were freely exposed to the air, on each surface a layer of cork was formed, which gave place to the underlying parenchyma when the two corky layers met. The other common method of healing was by cell-division on either face of the injury and was usual when the surfaces were not sufficiently separated to admit the air. (*Gard. Chron.*, May 23). — S.

AT THE CALL of a committee of representative persons interested in Maine botany, a convention was held at Portland, July 12–15, 1895. The different sessions were attended by about one hundred persons, many of whom expressed a desire to become members of a permanent organization, and as an outgrowth from this convention the Josselyn Botanical Society of Maine was formed. The second annual meeting was held in the State Normal School, Farmington, July 7–10, 1896. The general plan for the meetings is to devote the first two days to papers and discussions, and the last two to field expeditions into the surrounding country.

THE FIRST BULLETIN of the New York Botanical Garden, recently issued, contains a full statement of the status of this important enterprise. Of special interest to botanists is the agreement with Columbia University, whereby the large herbarium and library of the college is to be deposited with the Garden. This will make the latter at once a great botanical center, situated in surroundings which will give ample room for expansion, and for the proper development of every phase of botany. In the interest of botanical science in America it is to be hoped that Dr. Britton will find generous support for the development of his far-reaching plans. Such opportunities should develop more than a great taxonomic center, but to accomplish it New York must continue to be very generous.

OTTO KAISER has reinvestigated the nuclear division in various cells of Characeæ. He finds that mitosis alone occurs in all apical, segment, nodal and peripheral cells, in the nodal cells of the cortical lobes, the cells of the antheridia and of young oogonia. In the segment cells, especially in those of the so-called leaves, the aster, metakinesis and diaster stages are somewhat different from the ordinary form, being of the barrel type. Centrosomes were present with the resting nuclei as well as with all stages of their division. Fragmentation occurs only in the cortical cells of older oogonia, and in the internodal cells of the stem, of the "leaves," and of the older cortical lobes. Only in these is more than one nucleus found. Kaiser's best results

were obtained with material fixed in corrosive sublimate solution, or Hermann's or Flemming's fluids. Staining with Heidenhain's hæmatoxylin produced sharply outlined mitotic figures.

THE CORNER STONES of the Hull Biological Laboratory of The University of Chicago were laid July 3d, with appropriate ceremonies. An address was delivered by Dr. George L. Goodale, of Harvard University, upon "Some of

BOTANICAL HALL.

the relations of the new natural history to modern thought and modern life," in which the speaker made a strong statement concerning the claims of biology to a place in educational schemes and also upon the community. Head Professor John M. Coulter officiated at the laying of the corner stone of the Botanical Hall and made a brief statement concerning the purposes of the building. In the evening the visiting biologists were entertained by The University at the Quadrangle Club House, where informal responses were called for by President Harper. Among the visiting botanists present were: Dr. Geo. L. Goodale, Harvard University; Dr. T. J. Burrill, University of Illinois; Dr. T. H. MacBride, University of Iowa; Dr. Charles R. Barnes, University of Wisconsin; Dr. G. F. Pierce, University of Indiana; Dr. C. F. Millspaugh, Field Columbian

Museum. The accompanying cut will give some idea of the external appearance of the building, which will be ready for use in the spring of 1897.

THE RECENT TORNADO at St. Louis was so destructive that much anxiety was felt by botanists as to the fate of the Missouri Botanical Garden. In the absence of Dr. Trelease, Mr. C. H. Thompson, Acting Director, has furnished the following statement for the readers of the GAZETTE:

"The Garden was in the direct path of the storm, at the very beginning of the territory destroyed, and received less injuries than the region east of us. However, the damage done in the Garden is very considerable, the most of it being in the arboretum, where something like 160 trees were either uprooted or broken off near the ground, so that they had to be taken out. These, of course, were total losses. Something over 250 were very badly damaged. In many cases the tops of the trees were almost entirely carried away. Many of these, by judicious pruning, will in a few years grow to be beautiful trees again, while many are so badly broken that it is probable that they will die. The shrubbery was badly whipped and broken, but fared better than the trees. The bed plants were almost totally destroyed in the exposed parts of the grounds. However, these are now replaced. The wreckage from the trees is rapidly being gathered up, and the Garden promises by another month to be as beautiful as ever, with only the vacant places here and there to remind us of the ravages of the storm.

Buildings suffered somewhat. The Linnean house, which shelters the palms in the winter season, had the glass portion of the roof entirely demolished. The office building had the tin roof torn from the south wing, and other buildings escaped with slight damages. At the office building, where the library and herbarium are kept, no damage whatever was done to the contents of the building. No permanent damage was done to the Garden, and most of it can be repaired in a short time."

PROFESSOR E. L. GREENE, in the continuation of his "studies in Compositæ" (*Pittonia* 3: 43), presents further conclusions in regard to the "asteraceous" forms. Generic lines in this vicinity either were or are in a chaotic state, and possibly ever will be. Apparently species may belong to any one of several genera dependent upon the standpoint of the observer. In the present paper the genera *Oonopsis* (a new genus), *Xylorrhiza*, *Heleastrum*, *Dœllingeria*, *Eucephalus*, and *Machæranthera* are presented synoptically, *Aster* and *Applopapus* being the most frequent synonyms.

DR. JOHN K. SMALL, in *Bull. Torr. Bot. Club* (May), has taken Raimann's work on *Œnothera*, as presented in Engler and Prantl's *Natürlichen. Pflanzenfamilien*, and applied it to a study of North American materials. The composite character of this Linnæan genus was notably pointed out by Spach

in 1835, but his numerous genera, for some reason, were not largely accepted. Raimann adopted Spach's idea, but seems to have presented his conclusions in a more satisfactory way. Dr. Small presents fifteen genera as represented in North America under the single generic name *Œnothera*, the old name retaining but five species, such as *Œ. humifusa*, *Œ. laciniata*, *Œ. rhombipetala*, etc. Those having somewhat acquainted themselves with the genus will be lost for a time in the maze of revived generic names. A new genus, *Gaurella*, is described, founded upon *Œ. canescens* Torr. & Frem., a number of new species are described, and abundant opportunity is given for new combinations. It is to be hoped that such extensive fragmentation may not be found necessary in many of our large genera, or there will be a call for an international congress to define a genus.

WE HAVE RECEIVED a bulletin from the Alabama Experiment Station which should occasion some remark. It is Bulletin 70, and is entitled "The Flora of Alabama, Part V," by P. H. Mell, botanist to the station. The four preceding parts have never come to our notice, but the present one deals with the *Leguminosæ* and *Rosaceæ*. We suspect, however, that this is the first part to appear, as certain prefatory matters would indicate. The author seems to be aware that botanists have been doing something in the last "ten or twelve" years, for he says so; but just what, he is evidently uncertain about, as the list testifies. We would suggest that if an "up-to-date" flavor be desired for the catalogue, the conspectus of orders had better be changed in several particulars, at least by removing the gymnosperms from their unnatural position between dicotyledons and monocotyledons; some dubious species had better be investigated, and all of them should be substantiated by herbarium specimens; and more than all, Dr. Chas. Mohr's relation to this work should be clearly stated. Botanists outside of Alabama have known for years that Dr. Mohr has been working upon a flora of his state, and we have expected a model state flora, because Dr. Mohr's zeal and patient accuracy are well known. In the list before us certainly one-half of the *Leguminosæ* and one-third of the *Rosaceæ* are credited to Dr. Mohr alone; and we cannot believe that this extensive information was obtained from our good friend with the expressed intention of anticipating his own flora. In other words, Dr. Mohr must have granted a favor that has been abused.